

PROCEEDINGS
OF THE
99th ANNUAL CONFERENCE

**AMERICAN RAILWAY
BRIDGE & BUILDING
ASSOCIATION**



1994

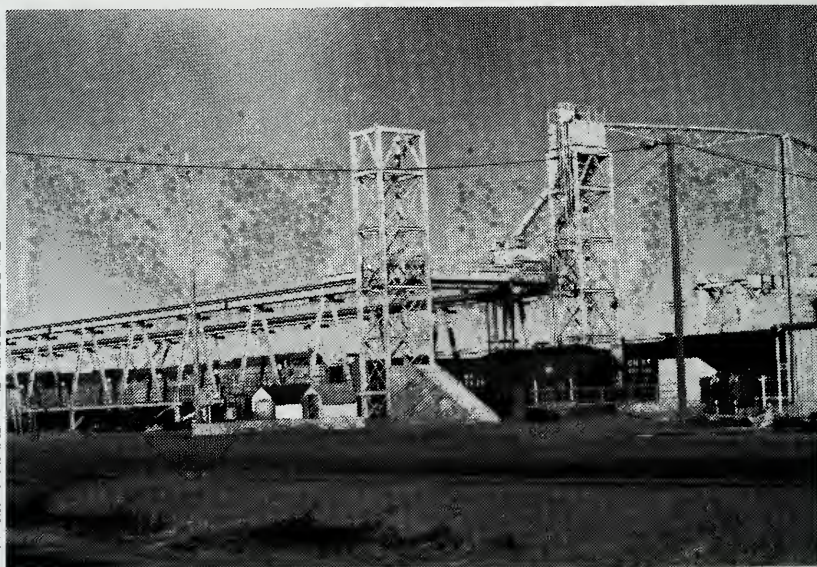


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**Proceedings of the
Ninety-ninth Annual Conference
of the**

American Railway Bridge and Building Association



Held at the
Westin Hotel Chicago
Chicago, Illinois

September 19-21, 1994

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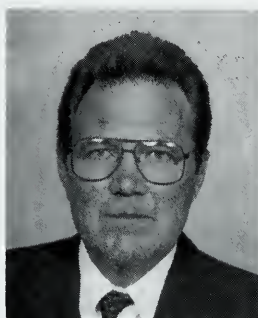


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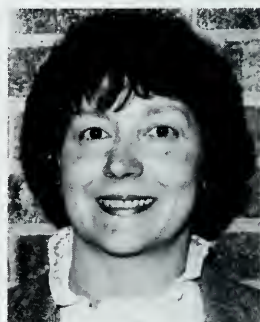


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JOINT SESSION

Monday, September 19, 1994

Opening Remarks

President Steele: As president of the American Railway Bridge and Building Association and on behalf of Gene Schubel, president of the Roadmasters and Maintenance of Way Association of America, I declare the 99th annual conference of the B&B Association and 106th annual conference of the Roadmasters Association open and in joint session.

I welcome each of you here today and I want to thank you for your interest in our two progressive Associations. The program reveals a lot of interesting topics and reports that are to be given and should be of interest to all.

There are three keynote addresses by three very knowledgeable people. They are: Herbert Robinson, vice-president operations from the Burlington Northern; Harris Wagenseil, vice-president of maintenance operations from the Union Pacific; and Jolene Molitoris, administrator of the FRA.

We have a little work for you to do this year. One of the things we ask that you do is complete the conference survey forms. These are the cards that will be distributed each day. It only takes a minute to fill out after each presentation. Today's card is red.

A second thing we ask you to do is pick up one of the committee sheets at the back of the room. B&B is yellow and Roadmasters is green. This is the basis for the 1995 program next year in Minneapolis. You have the next two and a half days to read through the scopes and decide which subject you want to contribute to. Don't be shy. Become involved — you'll meet a lot of good people that way and you'll be able to share your ideas and solutions to their problems.

As of this morning, the count for Roadmasters is 219, Bridge & Building is 76, suppliers is 162, and spouses and companions is 84, for a grand total of 541. It looks like we are on our way to a nice attendance.

Before we begin, I have a couple of housekeeping items that I would like to tell you about. In case of emergency, all the exit doors are marked as you can see. Northwestern Hospital is only a block away if we need their services. Several of the staff here are capable of handling CPR needs. The hotel's emergency number is 7777 and the City of Chicago's emergency number is 911.

It is proper at this time that we pause for divine guidance and inspiration prior to beginning this conference. I will now call upon John Horney, past president of the B&B Association, to give the invocation.

Mr. Horney: Would you please stand with me while I pray.

Our Heavenly Father, we stand before you at this time to thank you for providing a safe trip for those of us who have traveled to this conference. We ask, Father, that you be with the speakers during the conference this week to give them encouragement and guidance during their presentations.

We have come to this conference to learn and we ask, Father, that you provide an atmosphere of sharing during this conference so that all of us may learn from our peers. Finally, we ask that at the close of the conference you once again provide safe travel for us on our return trips home.

We ask these things in Jesus' name. Amen.

President Steele: Thank you, John. At this time I would like to introduce the officers and directors of the B&B Association. As I introduce each one, I would ask that each of them come stand in front of the podium. Please hold your applause until all have been introduced.

Senior vice-president, John Van Huis, chief engineer structures and production, Wisconsin Central; junior vice-presidents are Mike Bradley, project engineer, Conrail, and Joe Lileikis, manager bridge maintenance, Amtrak; immediate past president, Paul Saletnik, engineer of buildings, Chicago & North Western; and treasurer, Don Lewis, assistant engineer bridges, Illinois Central.

Directors are Bob Carter, general B&B supervisor, Burlington Northern; Carl Young, project engineer, Conrail; Dave Franz, bridge engineer, Kansas City Southern; Lee Hostler, structures engineer, Santa Fe; Jimmy Neece, supervisor facilities maintenance, CSX; Ron Kaye, bridge engineer, Illinois Central; Mark Johnson, manager structures, Burlington Northern; Tim Rich, engineer B&B, Conrail; and Dale Bartholomew, senior project manager railroad facilities, Sverdrup Corporation.

Gentlemen, this is my cast. (Applause)

At this time, I'll turn the podium over to Gene Schubel, president of the Roadmasters Association.

President Schubel: Thank you, Don. As president of the Roadmasters Association, I would add my welcome to all attendees to this important conference.

We on the Roadmasters board of directors feel the conference fully supports our mission statement which I quote in part, is to provide track maintenance professionals with a responsive forum to educate and to exchange ideas for the promotion of safe, practical, and efficient track and roadway maintenance.

The presenters and you have taken some of your valuable time to attend this conference. Use the opportunity to listen to the speakers, talk to your peers in the industry, and use your creativity, whether it be to find solutions to your maintenance problems, think of improvements to track materials or equipment, or think of new types of materials or equipment. The supply industry is here and this is an excellent chance for you to talk with them.

At this time I would like to introduce the Roadmasters Board and ask all of them to stand. Please hold your applause until the end.

We have first vice-president, Keith Nordlund, project manager, CN North America; second vice-president, Kendall Koff, manager of maintenance-of-way, Amtrak; and treasurer is Ron Poulsen, senior project manager, HDR Engineering.

For directors we have Wayne Russell, general director roadway maintenance and planning, Santa Fe; Ray Brosseau, manager of track programs, CP Rail; David Smoot, executive vice-president, Saganat; Darrell Cantrell, director of service agreements, Burlington Northern; Ken Johnson, regional manager gangs, CSX Transportation; Dave Kelly, vice-president of maintenance, Illinois Central; Al Cloutier, division engineer, Amtrak; Pete Murgas, engineer procedures and administration, Norfolk Southern; Bob Davis, production manager ties, Southern Pacific Transportation; and Dwight Clark, director quality management engineering, Union Pacific.

That is our board. (Applause)

At this time, we usually have the welcoming remarks from REMSA and AREA, but we are going to deviate from the schedule a little bit. It is my pleasure to introduce Mr. Herbert Robinson, vice-president of operations for Burlington Northern.

Mr. Robinson started his employment in 1971. He is currently located in Fort Worth, Texas, along with his wife and three children and functions as vice-president network design. He attended various universities such as Sangamon State University in Springfield, Eastern Illinois University and Lincoln Land Community College.

He began his career in 1971 in the maintenance-of-way department and that's why I asked Herb to speak to us. He also has a good maintenance-of-way background and he is an

operating officer so I thought he could really relate well to this group. He served in various track maintenance positions and continued his maintenance career as an assistant roadmaster in 1977, then roadmaster in 1978. He transferred to the transportation department as terminal manager and held a variety of transportation positions including operational analysis, division trainmaster, assistant superintendent transportation, and terminal superintendent. He was promoted to division superintendent in 1987 and general manager in 1988.

He was transferred to corporate headquarters as assistant vice-president network planning in 1990 and then promoted to vice-president network planning and control in 1992. Recently he was promoted to the position of vice-president network design, which is the position he now holds.

Some of his other affiliations and associations include the American Association of Railroad Superintendents, Air Brake Association, Benevolent and Protective Order of Elks, Kappa Epsilon, Lutheran Church, Y.M.C.A., Political Action Committee, Little League Baseball, and all the committees of Boy Scouts. As you can see, he has a lot of varied activities.

I now introduce Mr. Robinson.

KEYNOTE ADDRESS

Herbert Robinson

**Vice President Network Design
Burlington Northern Railroad**

Thank you, Gene, and welcome to everyone again. It is certainly an honor for me to have the opportunity to address a group such as yourselves on maintenance.

As Gene mentioned, I started out in the maintenance department back in 1971. Some of the things I am going to talk about today are some of the changes that we have gone through and also a little more on your theme which is training in the 1990s.

When I think about training, I think about a couple of given areas that we need to really focus on. One is the obvious technical training because of all the new equipment that is coming on line today. Whether it be welding, computerized tampers, new types of work equipment or whatever it might be, there is no doubt in my mind that we have to continue to improve our people skills by training. That is a big part of where we are going in the 1990s.

Another thing that we really need to focus on is an area that I call behavior training or mindset. What we are talking about is change. Big time change. If you look back over the last 20 years, we have really seen a lot of things happen in the railroad industry. You can talk about when I was track rider and the motor cars that we used to ride. I don't think many railroads have motor cars anymore. You can think about train orders from the transportation side. Today there are no train orders on the Burlington Northern and I would assume there are not many train orders on many railroads out there. Another example is fax machines, new ways in welding, computerized tampers and all those different kind of things. There were a lot of things going on and there was a reason for us to be able to develop that type of machinery and the skills that we had to have in our people.

When you think about it, why did we have to do it? Deregulation. The railroad industry was going through deregulation and for us to be able to survive we had to go through downsizing. We had to become much more efficient in cost controls and in productivity. In whatever you want to talk about, there had to be significant change in the railroad industry for it to survive. In fact, there were many people who said we wouldn't survive. If you look around today at all the different railroads, we really have survived.

We saw employment drop significantly. We saw machinery come on which became much more productive. Whether it was with CWR, whether it was with tamping or whatever it might be, the railroads had to become very productive. We had to eliminate assets for us to be able to survive.

That period is behind us now. There is a real change going on in the industry and it started about a year ago. We still have to be very efficient. We still have to be very productive, but the difference is if you look around you, we are in a growth industry. It's a big change. When you look at some of the articles that are being written today, and, by the way, I don't believe them, you will see a lot of those writers saying that managers of the railroads today cannot deal with growth and that we don't have the skill set to be able to deal with growth. I guess what I would do is challenge each and every one of you to think about that this week and how we are going to deal with a different environment than what we have all grown up with and that is downsizing.

We are now in a growth industry. Take a look at the Santa Fe with 10, 15, and 20 percent improvement increases in intermodal traffic. The coal traffic for the western railroads is again at 10, 15, and 20 percent increases in the volumes and demands that we have to face. How are we going to deal with those in the 1990s? With wise investment resources. It will be very easy for some rich railroads out there to over-invest in plans. It's very easy to go in there

and build double, triple and quadruple tracks in some locations and buy hundreds of locomotives and new equipment and those kinds of things and hire people as fast as they possibly can.

The successful railroads of the future are those that are going to be wisely investing their money. It doesn't mean that you don't expand. It doesn't mean that you don't add double or triple tracks. But it is going to be critical that each one of us in our railroad positions are a part and a player in wisely investing only where you need to invest because we don't want to wake up in an industry ten years from now in the position again where we are over capacity and we are going to be going through downsizing again. You won't survive if you take that path.

Another area that is very important is that it's not going to be business as usual. How do we plan and execute? Again, it gets back to efficiency, productivity, or whatever you want to call it. It is critical that we change how we think about planning and execution. You have to have a plan. After you have that plan, you have to execute against it. We have developed some of the greatest plans in the world only to find out that we didn't believe we wanted to execute against it. Again, what I am trying to relate to here is the mindset that we have. You have to think about how we plan and how we execute so that it's an integrated plan and execution.

Finally, the ability to change and to move out of your comfort zone. It's not very easy, is it? It's not very easy to change. I can think about fax machines, for example. Jerry Wood and I were working together here on the Chicago region headquarters and I was one of the guys who was lucky enough to be able to start installing fax machines. Do you know what the response was? You are crazy! There is no way a fax machine will ever work in this railroad. Well, fax machines have not only worked, they are now becoming obsolete as we are now going more to computers.

We have to understand in our minds and we have to open our minds to accept change. Change is good. Change is not bad. How we deal with that change will result in how successful we are as an industry in the future.

If you take a look at this, this is something that Burlington Northern is doing now as we try to better integrate our planning and execution. I call it the network design process and it is also a resemblance of an organization. Everything in here is very integrated so you have to be very careful when you think about it, but one of the things that we try to focus on is how we start our business plan. It is very critical that any planning that you are doing focuses on everything that has any kind of impact on your network.

What we start with is the obvious, the customers. The marketing department on the Burlington Northern, as an example is broken into three business units: coal, intermodal, and merchandise. Obviously what we have to do is start with the demand forecast as far as what the customer wants. Other things that have impact to the network include not only the passenger trains that we run here in Chicago and the Amtrak trains, but also our interline partners and the shortlines that have become a big part of the railroad industry. We need to understand what all the requirements are of those people who are going to have an impact on our network before we ever start to put a plan together.

The next thing we do is put that plan into what I will call a bucket and then we have to look at the areas that have to deal with these kinds of demands. If you take a look at that, we can start with line. What kind of impact do all these demands have on your line capacity, on your terminals, on your crews, on your locomotives, and on your equipment? Again, a very important part of it is the maintenance. You are damned if you do and you are damned if you don't, but you have to do maintenance work. There is no doubt about that and we have to be able to rebuild bridges. We have to be able to do signal work. We have to be able to handle the customer requirements and to provide reliable service. So all these things are here, but most importantly, maintenance has to be involved.

What is the impact on all these different things when you are trying to meet the customer requirements? The following is a look at all those kinds of things. What we do is look at the financial side. You have to be able to provide a return to your shareholder. You have to be able to earn money so that you can reinvest and all those kinds of things.

After that, we came up with a consolidated business plan. What is it and is it an annual plan or a seasonal plan? Most importantly, what we try to do is link that very closely to what we call our strategic plan. Everything that is going on down here on a real time tactical basis is also being fed into our strategic network design which deals with how many lines do we have to have in the future? Where should those lines be? Should we go into the short line business on a certain parameter? Should we go into a merger? These are the kinds of things that we are looking at.

All of this, then, has to be supported by decisions and support systems such as computers, models, and all those kinds of things to allow us to have the best possible plan on an ongoing basis.

What I would like to focus on now is getting into more of the specifics on maintenance. When Gene Schubel and Darrell Cantrell asked me about four or five months ago to talk to this group, they asked me to talk about maintenance scheduling and what we do at Burlington Northern. So that is what I would like to focus on now.

First of all, why did we even go to scheduling of maintenance of way? If you take a look, we needed timely access to information. We had a lengthy budget in our AFE process. Our schedules were not current. Our schedule changes were communicated manually and obviously that is not a very good position to be in. Our maintenance schedules also were a problem area.

Schedule decisions optimize at division level. What we are talking about here is that most of our scheduling was done at the division level. Whether you have five divisions or whether you have 25 divisions, if everybody is doing their own scheduling at the local area, it doesn't fit together very well when you look at the total network perspective. We found that to be a real issue on Burlington Northern.

At one time, we only scheduled large projects. If you only schedule your major production gangs, what happens to all the other maintenance that has to go on? It certainly has an impact on the network and we need to understand that today you have to schedule everything because they all have an impact on the network, on the customer, and all the things that we try to do to be efficient. We had a lack of integration with the marketing department. A lot of times what we had was the local roadmaster or the local section foreman out trying to get track time with the dispatcher and the dispatcher was not always tied into what the marketing demands were because we had decentralized dispatching. At some locations we had 15 or 20 different offices. We weren't tied in very well to what the market demands were. We had a lack of a long-term view. We also had a lack of tools and inflexible schedules. We could not easily identify the impact of change.

I will be talking about some of the tools that we have developed to help us understand that when we do a scheduling project what the impact is on the customer and what the downstream and upstream effects are on the total network itself.

We had an inability to see overall effects. We had no system-wide project management tools. We didn't do it from a centralized location and rescheduling was extremely time consuming. Again, we had no computer tools so everything that we did was manual with a pencil and pad of paper so it was not very timely. We had a lack of coordination. We had limited coordination for all of our schedules and we really had an inability to track or utilize our equipment or our assets. We really didn't monitor how well we were doing across the total network.

Finally, resource utilization. We had an inability to coordinate manpower, manpower planning machines, and equipment and so forth. So we knew that we needed to change what we were doing.

What was the major focus of maintenance scheduling? There were really three different areas. The first area was to integrate maintenance projects or all the things that we do with Burlington Northern operations. One of the things that I would point out is that maintenance at Burlington Northern is not an engineering function by itself. It is not a maintenance of way or B&B function. It's an operations function. In fact, the group that does the maintenance of way on Burlington Northern resides in the transportation department.

There were two other areas that we really wanted to focus on. Number one was to minimize the amount of disruption to our customers and to our trains. We needed to minimize that disruption and then balance that against maximizing productivity for all the gangs out there.

Again, what we have to do is we have to be able to provide reliable service. We still have to be able to do our track work and be as productive as possible. Those were the three major things we were focused on at Burlington Northern when we went into the maintenance scheduling effort.

Who were the contacts that were involved? Network design was described briefly at the beginning of the presentation. The system engineers obviously provided key input. They tell us what they need to do. They understand what is going on out there as far as a forecast. They are tied into the marketing demands and we need to know from them what they need to do. We then tell them when they are going to do it.

As far as network operations, obviously the field groups have to deal with that. The business or marketing groups, again, are tying in with what we are doing on maintenance and operations to what the customer requirements are. Burlington Northern is going to open a new network operations center in March, but they are obviously the ones to try and pull everything together at a central location.

Regarding purchasing and materials management, I am sure that there are some of those folks here in the crowd. You certainly understand how critical it is that you know what the needs of the engineering and maintenance departments are and how that is tied to a specific schedule so that you can reap the benefits of price leverage and delivery and all those kinds of things. Again, it's the customer.

Something that you can't really minimize at all is the foreign railroads. The impact of what is going on with your partners around you and what impact that has on your network. You need to understand what they are doing as far as track work and what you are doing as far as track work so that the customer is not the one that suffers from that.

What are the activities that we schedule at Burlington Northern? We schedule everything. We started out, as I mentioned, with just a few projects such as the major production gangs that we scheduled. Today we schedule everything except for emergencies. Obviously we haven't got smart enough yet, but we are working on scheduling that, too, and how we are going to schedule broken rails, weather, derailments, and all those kinds of things. If anybody has any ideas, I would really appreciate the input.

What are some of the tools that we use? Roadway coordinated planning tools. Engineering enters all of the future roadway plans on this system and then we extract the information for the schedule.

The engineering estimating system, again, is what gives a detailed estimate that is provided to us so that we understand what materials are needed, the manpower requirements and everything that is needed in a detailed estimate.

The maintenance scheduler is a stand-alone system that we use for scheduling maintenance projects. It is used right now in the interim as we move to our new network operation center that I talked about. You can see the network execution plan which is a new computerized system that will integrate all Burlington Northern systems, but the maintenance scheduler is something that we use at this time to be able to do the scheduling on the maintenance side.

A slow order predictor is used when we are scheduling maintenance. We build into an algorithm the ability to understand what impact we are going to have on slow orders and con-

gestion. We use that so that we can give feedback to the customers and to our operating people what impact there will be by doing whatever project it is that we are talking about.

A service maintenance planner is a system that deals with all of our train and car schedules. What we do is start with that and plug the projects in so we can understand what changes we have to make. I will show you a couple of examples of that later on.

The roadway labor distribution report is an electronic payroll and labor distribution system which also includes production reporting.

The slow order management system is a system that we use at our network operation center which tracks all slow orders on the Burlington Northern by the minute. For example, on the Chicago to Seattle corridor if we get over 60 to 80 minutes slow orders based on the gangs that are working out there whether it's a section gang or a production gang, we then know that is starting to have a serious impact on our ability to provide reliable customer service. We manage against thresholds on each one of those segments and we break it down by large quarters as well as by specific subdivisions.

The track reservation system is something that we require of all our people in the field. This says that anything from one day to one week out has to have a reservation before they are able to occupy the track. What they do is send their request to a centralized group who then puts together the plans to make sure we communicate not only to the people who need to do the work, but also to our customers and our transportation people. In this way, we have a fully integrated plan every day of every week.

Finally we have the network execution plan which, again, is a system that we are developing right now that will come on line in 1995. This system deals with integrating not only our dispatching systems but also our transportation systems and all of our maintenance schedules, too.

Those are a number of the planning tools that we use in trying to provide better schedules. I have a couple of examples of the new control center or new operation center that Burlington Northern is building. We announced this a little over a year ago and started construction last August. It will be completed in March of 1995 and we will start our transition that will include everything. We are going to have about 125 desks in this center. It is about 183,000 square feet of facility and the key thing that we are trying to accomplish here is the integration of all the things that have any kind of impact on the network into a room with the same type of computer equipment. As an example, not only will the dispatchers be in there, but we will have a maintenance scheduling desk, an intermodal desk, our communications desk, and network control center that is now in St. Paul. We are moving down there and being a part of this center. We will have every function necessary on the Burlington Northern in one location with state-of-the-art technology to hopefully better manage our railroad. That is what we are trying to do.

What are the benefits of having an integrated operating plan? Since the concept of scheduling maintenance at a central location became a reality in 1992 on Burlington Northern, there have really been some significant milestones. There are a couple that I will touch on.

Our track time for production gangs, as an example, has gone up from 58 percent to 72 percent. Our machine power planning has a better forecast and can respond much more quickly to falls in manpower in a specific area. Our materials department has their requirements by September of the prior year and can plan their materials distribution for major production gangs well in advance. This ensures not only timely but also more efficient material distribution.

Our centralized scheduling of maintenance activities has also allowed our work equipment to be much more effective and much more efficiently used across the system rather than staying on each specific division or region. Probably one of the most important things is something that we in the maintenance area sometimes want to forget and that is the customer impact. We all have responsibilities. We all have work to do and we all have our bosses push-

ing us to be more productive. However, we have to always remember why we are out there and who is paying the bill. We have to remember that the customer is a big part of this. It doesn't mean the customer is always right.

Believe it or not, one of the things we do when we do our maintenance scheduling is we understand what the impact is going to be and there are many examples of being able to go to the customer, explain what track work we are doing or what B&B project or what signal cutover we are doing and they understand that. But it's a way of communicating what their expectations are and what our expectations are and then coming to an agreement. This is a big opportunity for us here.

I will go through a couple of quick examples of how we do some of our maintenance scheduling. I told you about all the contacts and some of the tools that we use. One example of the materials that we use is called a string line. The lines going up and down are actually train schedules and when those trains are actually running. What you see in the middle of the box is an example of a block of time that we need to do a certain track project. This is a rail gang and what it says is we would like to have a six and a half hour window from 6:00 a.m. in the morning to 12:30. Obviously right here it shows that there is no conflict so it's a very simple thing to schedule. We can give them a six and a half hour window without affecting trains at all.

The next one here gets a little more complex, but it's not near as complex as some of them. What we are trying to demonstrate is a conflict in the window. So how do you deal with that when you want a six and a half hour window and it is right in the middle of a train going through? This is train number three which is a high priority train on Burlington Northern. How do you deal with something like that? Here is one way to look at it. You work with the customers, you work with the transportation people, and you adjust the train schedule. We have the ability to do that on a real time basis so once we are able to understand that and we know that the customer will still be able to meet his requirements, we can change that train's schedule. That is one example of what we can do.

Another example is balancing between making reliable customer service and maximizing productivity. There is another way we can do it. We can split the window and give them a four-hour window, let the train run through on time, and then give them another two or two and a half hour window. That is another example of how you could deal with that.

This example here is just to show you that early is not always good. One of the things that we at Burlington Northern do is what we call precision execution. You who have worked out there on the track certainly understand the times that you have gone out there and they said that they would give you the track and all of a sudden here comes one of those trains that was running three or four or five hours early and they say to get the gang off the track.

We don't do that at Burlington Northern. What we say is that the train is going to run on time. If that track gang has been given a reservation out there to have the track, that train will be held and run on time. It's a little bit different than what we have done in the past at least where I came from.

There is a little saying that I try to share with my people because change is not easy. I started out talking about all the different changes that we are going to have to go through and I'll tell you something I am reminded of. When nothing seems to help, I look at a stone cutter hammering away at his rock perhaps 100 times without as much as a crack showing in it yet. At the 101st blow, it will split in two. I know it was not that blow that did it, but all that had gone on before.

The point I am trying to make here is we need to be patient. We need to persevere. You need to have a sense of urgency — there is no doubt about that, but change does not come easy. It is very difficult to accomplish and it's very difficult to get up and go back to what I talked about at the very beginning which is your comfort zone. It is very easy to go back to your comfort zone and say, "I told you that would never work." You have to be patient. You

have to understand and demonstrate what the benefits are. Whether it's scheduling maintenance or whatever it might be, you need to be patient and persevere and move forward. Looking back to the past, think about the way they started laying ties with horses and buggies and think about all the changes. Think about the motor car and think about all the changes. Think of the equipment that you have seen and think of all the changes in the last 20, 30, 40, 50, even 100 years. Think about the changes that are going to be coming in the future. That is a real critical issue.

What we are about to do is embark on an incredible journey. The 1990s are going to hold significant change opportunities for all of us. We are in a growth industry. It's an era of railroad glamor, some people say. It's the golden age of railroading. Think about how you fit into that. Think about how you are going to change. Think about the training that you have to have whether it's on the technical side or whether it's on the behavior side. Because those of us who deal with that change and those of us who understand what tools and training will be required to make those changes are going to be successful railroaders in the 1990s. Thank you. (Applause)

President Steele: Thank you, Mr. Robinson. That was an excellent talk. The remarks are very important to this group. I would like to give you a small token of our appreciation. We have a cup with the Roadmasters and B&B logo on it and I would like for you to have that. I appreciate your time and effort.

Mr. Robinson: Thank you. (Applause)

WELCOME BY PRESIDENTS

President Steele: At this time I would like to turn the podium over to Mike Franke, president of AREA to make a few remarks.

Mr. Franke: Well, seeing Herb Robinson's slides, I am reminded of the centralization that the Santa Fe went through over the last two or three years and how traumatic it was at the beginning. But as time goes on, it gets better and better coordinated and the communication gets better and better as all the people that fit into the so-called network talk to each other in one room and are able to react very quickly to the emergencies and changes that occur every day. But it is a patient type process. You have to have patience. Herb is right on.

Thank you for allowing me to make a few remarks at the opening session of your convention. On behalf of the members of the American Railway Engineering Association, I would like to extend congratulations and good wishes to both presidents Gene Schubel and Don Steele and to all members of the American Railway Bridge and Building Association and the Roadmasters and Maintenance of Way Association of America. Your contribution to the advancements in the construction and maintenance of railway track and structures have been of great value to the railway industry.

Our three organizations, together with REMSA, have had an excellent working relationship in meeting the challenges that face the railway industry. In the past, in the very traditional type past, the main objective for maintenance-of-way supervisors and railway equipment manufacturers was to develop new work methods, procedures, and equipment to reduce the cost of track and bridge maintenance.

Echoing what Herb has said today, we must look at the complete picture of quality and economic service to our customers. Those strategies include safety as number one, on-time service and, of course, continuing with cost containment. To achieve those objectives in today's world of railroading means we have to maintain our infrastructure in excellent condition with the least possible cost and improve the quality of our transportation services while at the same time accommodating the increasing traffic that continues to set new records every year.

This potential conflict between the track side and the transportation side is the challenge that we, as railway maintenance professionals, face in the 1990s. However, I am confident that working together with the same commitment that we have shown to attack problems, we will meet the challenge that our growing businesses create through continued innovation and forward thinking.

I would like to take this opportunity to invite everyone to attend the AREA fall conference in Montreal on October 6 and 7 which includes the various technical presentations and a train trip between Montreal and Quebec City. Of course, the AREA March conference will be held in conjunction with a REMSA mini-expo here in Chicago at the Palmer House on March 19 through 22, 1995.

In closing, I would like to wish all of you a very productive and constructive meeting and I thank you for your time. (Applause)

President Steele: Thank you, Mike. It is now my pleasure to introduce Ken Norton, president of the Railway Engineering Maintenance Suppliers Association, or REMSA. REMSA members extend their hospitality to us throughout this conference by supporting the continental breakfast that we enjoy each day in addition to opening their doors for us each evening. So every time you talk to a REMSA representative, be sure to thank them for their help and assistance.

I would like to now introduce Ken Norton.

Mr. Norton: Don, thank you. Presidents Steele and Schubel, distinguished guests, ladies and gentlemen, good morning. I bring you greetings from the 216 companies which make up the Railway Engineering Maintenance Suppliers Association or as Don mentioned,

better known as REMSA. I also bring you greetings from the executive director, Judi Meyerhoeffer.

As REMSA's current president, I am proud to appear before you today and REMSA is proud to be part of your conference. One of my jobs and one of my primary objectives as president of REMSA has been to place continued emphasis on this organization's professional side. It has really always been there but we have just decided to emphasize it more. Why? There are really several reasons. Chief among them is the fact that there is really a large amount of impressive talent on the REMSA side and the firms that make up this organization.

Secondly, downsizing, or as we have just heard I guess we have to rephrase it to right-sizing the railroad industry, has left some technical voids. It is our opinion that many of these voids can be filled by tapping into the talents that exist on the railway supply side and we just simply want to make that fact known.

Additionally, it is our belief that the rail industry needs support in Washington to help promote favorable legislation and also stem the tide of the ever-increasing unfriendly initiatives which surface there.

Indicative of the new REMSA, we have continued to be active in the railway supply coalition. This organization's principal objective is to create a form of unanimity among the various railway supply organizations and a unified voice in Washington. We have been asked and have attended the last three round table discussions sponsored by FRA administrator Jolene Molitoris. We were asked by Ms. Molitoris, and we complied, to become part of the group that represented the U.S. rail industry at the Pan American Rail Conference.

We continue to play an important role in the FAST Steering Committee and REMSA is an active CRASH supporter which, as you know, is fighting the heavier and longer trucks. These are but a few examples of the more visible and vocal roles that REMSA is playing to assist you, the railroad, to become the nation's number one transportation mode. It goes without saying that we know that our success depends upon your success. We respectfully request continued recognition that your success depends upon productive professionals interfacing with us, those who provide you with products and services vital to your financial prosperity.

I want to express my sincere thanks to both Don Steele and Gene Schubel for the time they have allowed us in their conference agenda. REMSA has two agenda spots. One is at 2:25 today at the B&B session and another at 8:35 a.m. Wednesday in the general session. To put these presentations together, we asked all of our member companies for products and services that they consider to be new and hot. So if you want to know what is new out there, I encourage you to attend these presentations. Again, these presentations are produced and directed and even presented by Vin Terrill. Vin is a former chief engineer and a former president of a supply company. He is a former president of AREA and a former president of REMSA. I challenge anybody to meet those credentials.

I also would like to remind you about two upcoming REMSA events. We have changed the name of what we used to refer to as the mini-show because that has connotations that really weren't true. Technology 2000 is an indoor display which is in conjunction with the AREA next March. Technology 2000 has an indoor and outdoor display in September, 1997, in conjunction with the B&B and Roadmasters in Kansas City.

I mentioned our increased emphasis on the professional side, but I do need to also tell you that we have not neglected our social side. We continue to sponsor the morning coffees prior to each morning meeting and we also have a reception tomorrow evening from 6:15 to 7:15. Many of our member companies and sponsors have hospitality rooms where you can relieve the tension of the day and even talk a little business. I do wish you a very successful conference. Thank you. (Applause)

President Steele: Thank you, Ken. At this time I would like to introduce our next speaker, Cliff Shoemaker, director of industry and public projects for the Union Pacific. Cliff began his career in the engineering department in 1967 after completing his studies at the

University of Nebraska majoring in engineering and business management. His current responsibilities include administration of all highway projects as well as industry development for the 19 state Union Pacific system.

Cliff is a member of the Roadmasters Association, past chairman of the American Railway Engineering Association's committee on grade crossings, current chairman of the Association of American Railroads Policy committee on highway-rail programs, chair-elect of the Program Development Council of Operation Lifesaver, member of the Transportation Research Board's committee on grade crossings, Board of Directors of Operation Lifesaver, Inc., and several other national and local committees involved in highway-railroad safety, research, construction, and maintenance.

May I introduce Mr. Cliff Shoemaker.

GRADE CROSSING ACCIDENTS

Cliff Shoemaker

**Director of Industry and Public Projects
Union Pacific**

Thank you. I appreciate the opportunity to be here today. This group as a whole is a primary mover and shaker, if you will, in grade crossing safety. We always think of the signal side, the educational side through Operation Lifesaver, the enforcement side and so on, but hopefully as I go through some comments you will see how big a part you do play in this effort.

The topic is grade crossing accidents and I am going to expand on that a little bit and talk about the accidents and some statistics and so on. But more to the point, I would like to talk about what we, as a group on the maintenance side, can do to prevent accidents and reduce our potential liability.

Highway rail grade crossing crashes have for many years generated the most fatalities of any rail industry related incident, many more than all other forms of fatal incidents combined including those related to derailments, head-on collisions, maintenance and operating personnel incidents and so forth. Please note that I am using the words crash or incident instead of accident as we believe that the vast majority of these incidents can be avoided.

The good news is that there has been a tremendous decrease in the number of crossing-related crash fatalities and personal injuries in the past 20 years or so.

Since the early to mid 1970s, which is when the Federal Grade Crossing Safety Improvement Program started to have a significant impact and when Operation Lifesaver activities were really expanding, there has been a 60 percent reduction in the instances of public highway rail crossings with a related decrease of fatalities and personal injuries of over 50 percent. The bad news is that there were still over 4,000 crashes in 1993 resulting in 517 fatalities and 1,677 personal injuries.

In addition to the obvious trauma that the injured parties and their families and friends must endure as well as the memories our train crews and other employees involved in these incidents must live with, these incidents cost the railroad industry well over \$100 million annually and that's off the top, I might add. This number is increasing despite the reduction in the number of incidents.

So what has all this got to do with the track and B&B personnel? Plenty. In almost all cases, the plaintiffs in court will argue that something was physically wrong at the site of the crash. Vegetation control was not performed properly to allow for the driver to see the train in order to stop safely. Crossbuck signs were missing or were not maintained properly. Maintenance-of-way supplies were stored adjacent to the crossing and partially blocked the view of the incoming train. Rail equipment including maintenance of way equipment was occupying a track adjacent to the mainline obscuring the view of an on-coming mainline train. The crossing surface or approaches were in such bad condition that the driver was so preoccupied in negotiating the crossing that he or she could not be expected to adequately look for oncoming trains. Many of you have had to give depositions or appear in a courtroom and you know exactly what I am talking about. While another argument may or may not be relevant to the case, the juries are often looking for any excuse to find the railroad negligent in some area so that they can assess damages against us.

So what is our responsibility? Different states and local political jurisdictions will have different statutes and ordinances, but generally the following is consistent in all jurisdictions: Maintenance of signs and signals at the crossing are usually the responsibility of the railroads. A determination of which public crossings are in need of some device in addition to crossbucks and what type of devices are appropriate is made by the agency having jurisdiction over the roadway. These determinations are generally made by the state highway department or the Department of Transportation. This process makes a lot of sense as signs and signals at public crossings are, in fact, highway traffic control devices. They don't control the operation of trains. These devices are not unlike the other devices that we see every day on the nation's highways. However, once these devices have been installed, the maintenance responsibility is often assigned to the railroad either by state statute or agreement or both. Exceptions to this include advance warning signs and pavement markings which are the responsibility of the highway agencies.

Traffic control devices for use at public crossings are described in Part 8 of the Manual on Uniform Traffic Control Devices or the M.U.T.C.D. Those of you in the public works area know well what that is. Those of you on the maintenance side may not. You should talk to your public works folks and get an idea of what that is. Hopefully your common standards are in line with the manual. This manual has been adopted by the Maintenance Department of Transportation, Federal Highway Administration, and has been designated as the national standard under Chapter 23 of the United States Code. All states have adopted this manual or have developed their own manuals which at a minimum must include these provisions that are in the federal manual.

The M.U.T.C.D. provides that at a minimum one crossbuck sign shall be used on each roadway approach to each crossing alone or in combination with our traffic control devices such as flashing lights. It further provides that where physically feasible and visible to approaching traffic, the crossbuck signs shall be installed on the right-hand side of the roadway on each approach to the crossing. Additional signs or reflectivity on the backs of signs may be required in some circumstances.

Some states have adopted double face or double back striped signs as their standard. It is important to remember that in almost all cases at least two signs are required on the right-hand side of each approach to the crossing. In other words, our old guidelines of one sign with reflectivity and markings on both sides of that one sign does not meet the minimum requirement.

In addition to the crossbuck signs, multiple track signs are required where more than one track exists. This sign is optional at crossings with automatic gates. The location of these signs is also important. The normal lateral distances are six feet from the edge of the highway shoulder or twelve feet from the edge of the traveled way in rural areas and two feet from the face of the curb in urban areas. Where unusual conditions exist, variations determined by

good judgment should provide the best possible combination of views and safety clearances available.

Where it is physically not feasible to follow these guidelines, placement of the cross-buck signs on the left-hand side of the roadway is acceptable. Some examples of that is where you have a building or some other fixed facility on the right-hand side. Crossbuck signs should normally be located a minimum of 12 feet from the center line of the nearest track at a height of 9 feet above roadway level. This height may be varied as required by local conditions such as an extreme approach grade.

While these guidelines may seem unimportant, adherence to them is necessary to ensure that the motorist is given proper notification of an approaching crossing. The driver is required to control his vehicle and operate at a speed that is safe for the conditions that exist at a given location. The Uniform Vehicular Code, or U.V.C., requires a driver to stop or yield to trains at crossings whenever a clearly visible electric or mechanical signal device gives warning of the train, when a crossing gate is lowered, or when a human flagman gives or continues to give a signal of the approach or passage of a railroad train.

A train approaching within 1,500 feet of the highway emits a signal audible from such distances if such train by reason of its speed or nearness to such crossing is an immediate hazard and when an approaching train is plainly visible and is in hazardous proximity to such crossing. Different states may have some minor differences in these guidelines but they are fairly consistent throughout the country. Accordingly, it is important that we try to keep our rights-of-way clear of obstructions especially for the 50 feet or so either side of the center line of the main track. The requirement for the driver is to stop or yield no closer than 15 feet and no further than 50 feet away from the track when any of those conditions above have been met.

Looking down the track, we should try to keep the right-of-way clear for a minimum of 250 feet. That is to be consistent with our own operating rules. This also goes for rail equipment, standard, or multiple tracks. Obviously there are some situations where this is not feasible when we are working immediately adjacent to the crossings but please don't store your stuff there. We have an option of where we store our maintenance of way equipment, ballast, used ties, and other maintenance-of-way equipment, and we should keep them out of the crossing quadrants or ensure that they don't block the view of an oncoming train.

Richard Reynolds and I were talking the other day about a recent situation in Texas on the Union Pacific where we got stuck for millions at a passive crossing with crossbucks. We had allowed county engineering for many years to store ballast and roadway equipment on our right-of-way. This amounted to about a 20-foot high pile of rock and dirt on our right-of-way. Even though that was not the primary cause of the accident, it was enough for a jury to find us guilty. I don't know how it's going to come out on appeal, but this is an example of what can come up. So please keep that stuff away from the crossing.

The crossing surface and approaches is another area that should be addressed. Generally the railroad is responsible for maintenance of the crossing surface to the ends of ties or about three feet outside of each rail. This does vary from jurisdiction to jurisdiction and you should become familiar with local requirements in your area. We have some local ordinances for example that require us to maintain the paved surface all the way to the edge of the right-of-way. Those are normally local rules; however, the state laws typically are the two feet area outside of rail that I mentioned.

The rule of thumb for crossing surfaces is that the surface should be consistent in ride quality with the intended use of the roadway so that there are no sudden changes for the driver to negotiate. In other words, we don't need to use a high quality rubber or concrete on our crossing for a gravel road. On the other hand, if we do have a busy highway, truck route, designated school bus route, and so forth, we should maintain it to a slightly higher level to be consistent with that roadway.

The width of the crossing should also extend past the edges of the roadway where possible. That is to prevent someone who is driving along the edge of the road from getting hung up on the tracks or if you get a no sand and ice condition that the guy doesn't slide off into the roadbed.

Another sign usually maintained by the roads is the whistle board or a whistle post. These signs are not usually required by statute but are covered in our common standards. Most state statutes provide that road equipment sound their whistles or horns a minimum of one quarter mile in advance of all public crossings and sometimes at certain private crossings. Therefore, whistle boards should be placed no less than one quarter mile from each public crossing and further away where physically necessary.

We also got stuck, or at least partially stuck, where we had a crossbuck that was located about 1,315 feet and the plaintiff went out and measured that. So if the guy didn't actually hit it in advance of that point, it didn't give full whistle warning. Again, they are looking for any excuse at all to find guilt against the railroads so please pay attention to these standards.

We should also become familiar with operating rules that pertain to crossings: when a flagman is necessary, when maintenance equipment and work trains should be spotted near crossings, and cross signal equipment operate, can all contribute to crossing safety.

Herbert Robinson mentioned the incredible journey we are about to embark on. I agree 100 percent. There are a lot of things happening in the grade crossing area also. There are a bunch of activities currently underway designed to address crossing safety. On June 13th of this year, Transportation secretary Federico Pena announced a new crossing safety action plan. Jolene Molitoris is on your program later this week and I suspect she will mention that plan in some detail so I will just hit on some highlights. While a plan has not been passed in its entirety by Congress, it offers some encouragement with some significant changes on the horizon at the federal level in grade crossing safety. The plan covers over 50 separate issues related to crossing safety including the broad categories of crossing research, private crossing issues, trespassers, the improvement to the existing crossing improvement programs, the 130 program, highspeed rail issues and crossing closures.

Within these areas are included such items as research on the effectiveness on the reauthorization of rolling stock, conspicuity of locomotives including alerting lights and whistles, and improvement to passive signs. Private crossings have always been a hazy area where very few states have jurisdiction over them and a mixed bag of warning device treatments. Trespasser incidents have continued to rise in recent years to the point that trespasser fatalities are almost as high as crossing-related fatalities. There were almost 500 of them last year. Of course, the problem with trespassers is we don't have good data on where they are occurring and with what type of people. We don't know if they are people fishing off a bridge, ATVs, aliens coming across the border, people hopping on trains and so on. One of the first goals is to establish a good data collection device to find out where these incidents are occurring so we know where to tackle a program. The stated goal of the action plan is not to make trespassing safe, but to reduce the amount of trespassing through education and enforcement.

One of the major bullets in the action plan is the initiative to substantially reduce the number of crossings in the country. I am sure you maintenance-of-way people can appreciate that from a maintenance standpoint, both public and private. To assist in facilitating that goal, a committee made up jointly of state, federal, and local officials as well as railroad representatives has been meeting to develop tools and guidelines to assist in the crossing closure process. That's another committee I have been actively involved with in this last year or so. We anticipate a brochure as well as handbooks on this topic will be published and distributed in the next several months. The intent is to provide you, the users, the tools that you need to initiate the crossing closure process including identification of the candidates for closure, which ones are the most likely to be successful in closure, the contact people who should be part of the closure team, and the general tools on how to attack the problem. The action plan

also proposes cash incentives be made available through federal funding to local public agencies to facilitate the closure process.

One example of how that was done in the past is the State of Nebraska has a cash incentive program whereby the state will give a city or county \$5,000 cash if they voluntarily close a public crossing. The railroad is also required to give \$5,000 cash. That is a cheap investment. If your management is giving you struggles over paying cash incentives, I would suggest that you take them there to look at it. Just one rehab of a planned crossing is going to cost you over \$5,000 as you are all aware. If you can get rid of that thing permanently for \$5,000 or even more in some cases, it's well worth the investment.

I am sure everyone in this room can name numerous crossings that are redundant and not essential for highway capacity needs, yet as long as a grade crossing remains open, the potential for a crash is always there. Local maintenance personnel probably have the best idea where redundant crossings exist and input to your public projects departments or to state crossing coordinators would be very welcome.

To summarize, there are many things that you can do to reduce the number of crossing crashes and improve highway rail safety. You can ensure that signs are in place, properly located, and properly maintained. We can ensure that our rights-of-way are kept as free from site obstructions as possible on their grade crossings, removing vegetation and trailers and supplies from crossing quadrants wherever possible. We can maintain our crossing surfaces to a level consistent with the intended level of usage of the highway. Through increased training we can ensure that the operating rules pertaining to crossings are enforced. We can work with Operation Lifesaver and other groups to educate people as to the hazards of crossings. We can reduce the number of crossings through cooperation with public agencies that eliminate some locations from the potential of a crash.

These efforts are all generally low cost efforts. I am not talking about grade separating or signalizing every crossing. That simply isn't feasible. What I am talking about is ensuring that statutes, ordinances, standards, and rules be adhered to and that we all make an extra effort to make grade crossing safety a part of our every day activities. Thank you. (Applause)

President Steele: Thank you, Cliff.

Mr. Van Huis: Our next presentation is Duncan MacLennan and the subject is the construction of CN's new tunnel under the St. Clair River.

Mr. MacLennan graduated from the University of Saskatchewan in 1963. He has worked in the maintenance, operations, construction, and special projects division of the Canadian National his entire career. Mr. MacLennan has lived in six Canadian provinces and worked in all ten. He served as assistant chief engineer – track and structures in Montreal and is now chief of construction for CN North America and vice-president of the St. Clair Tunnel Construction Company of Sarnia.

CONSTRUCTION OF CN'S NEW TUNNEL UNDER THE ST. CLAIR RIVER

Duncan MacLennan

Vice-President

**St. Clair Tunnel Construction Company
CN North America**

Good morning, ladies and gentlemen and members of REMSA. It's a pleasure to be with you here.

As Keith Nordlund, the Roadmaster's first vice-president, told you a couple of years ago this is the exact day we were supposed to be running trains in the project. Well, I will show you why we are not doing so.

As I said, we were going to be running trains, but we ran into some problems with bureaucracy as the mayor of Detroit threw a little mud into the permit process for a while. For those of you who may not be aware of where Sarnia is, that is where Port Huron runs more or less north and south so you have Canada on the right-hand side and the United States on the left-hand side.

The tunnel runs from the Canadian side through a petro chemical industry and a less industrialized area on the American side. The new tunnel goes from the Canadian side and slopes towards the American side whereas the existing one goes the other direction.

The tunnel is drilled through what appears to be gray on the screen. That is special clay that is found only in that part of North America. Unfortunately, it gets a little softer down about 110 feet below ground level. The challenge to the tunnel is the lack of depth between the bottom of the river and the top of the tunnel. In a lot of places we have less than 15 feet of cover and contractors would have preferred three diameters of cover which would have been 90 feet.

That's the tunnel as it was before we began the process. Up at the top just a short distance beyond the tunnel drive is an Esso research laboratory with an electron microscope in the basement so really, if you had your druthers, you wouldn't want to start tunneling without learning something about that type of activity.

That is the old tunnel itself. It's still structurally sound, but you can see it just will not handle double stacks and triple automobile cars. There we are attempting to show the lining of the old tunnel and steel liner plates down at the pumping station. About halfway through you can see the Port Huron exit on the picture. This is the Canadian side in its pristine situation before we began to work.

Initially we thought we were going to have to relocate some piers on this bridge. We did alter the alignment to get around them.

That is the TBM itself. It is an earth pressure balanced tunnel boring machine. It is just a little over 31 feet in outside diameter and is the biggest soft ground tunnel boring machine in North America. You can see on the front of it those red things which are disks. Disks are put on the machine if you are encountering boulders of rock. Other than that, there is a line of picks that pulls the clay in. Those picks and disks can be changed from inside the machine.

This is still in the plant and it gives you a shot of the tail end. There are really three sections to the machine, the front port where the bulkhead is, the main working area with jacks and the erector arm. What is not shown is a can that fits back around the tail end. That erector arm grabs the segment and it pulls them and rotates to about 360 degrees.

Muck comes out of the bulkhead up through a screw auger, is deposited down on the conveyor belt system, travels out beyond the segments and is dumped into muck cars. The

real guts of the TBM is the forward bulkhead in front of the screw. What you attempt to do is keep enough pressure in this bulkhead that you are exactly at the required overhead pressure. Right now we are running at about 4 and a half bar to make the soil think that it is in balance. Obviously if you take more dirt up out of the screw and empty the chamber, more dirt is going to come in and you are going to have settlement. Conversely, if you don't excavate enough material out of the bulk with the screw, the machine is strong enough to mush ahead and you would have lifting of the machine. So it is quite an art as well as a science to balance the thrust, the rotation, and the consistency of the mix.

That is a computer version of what is formed inside the tail sphere. Each one of those segments, and there are six of them plus a key ring, is 15 feet long, five feet wide, a foot and a half thick and weighs about seven tons. We came up with the 27 foot floor internal diameter. This was developed by using the AREA clearance recognizing a possibility in the future of putting in a slab track. You can also electrify, in the future, if it were to happen in the next 100 years.

That is more or less what the finished product will look like. Fans, lights, and services. One change that is made now is we don't have all the cable ducts that were going to cost about \$2.5 million so we just have a slot down one of the sidewalk sections now.

Here we have train loads of segments delivered from Woodstock, Ontario.

That is what happens when your train is delivering and you are not tunneling.

There is the TBM itself being erected. You cannot take a 32 ton can and haul it down the highway or the railway so it came in two special train loads of parts.

Here again is the pristine research laboratory. It is very much a futuristic building with a glass front and we were really concerned with tunneling under it. If we didn't control settlement, we could have ended up with some disastrous consequences. We went to quite elaborate plans to protect settlement. Esso is one of our biggest customers. We went under a number of tanks, an awful lot of service facilities, and finally the river. What we attempted to do is bring in a grouting. We went over to Europe and saw it. What you do is shaft. In a shaft there is a series of grout hole pipes that fan out at two elevations under the basement. There are really two levels of fans. The shaft on the left puts out another two levels of fans where you can grout at any specific location under the building. We went in and preheated at about ten millimeters, which doesn't sound like much, but we had a very sophisticated leveling monitoring system all around the building and internally. With a little bit of computer gadgetry and wiring and very sophisticated leveling performance you could monitor any point in the building for some supposed settlement. I am happy to say that that part of our operation was extremely successful.

We preheated to ten millimeters. As we drilled through the tunnel the pressures were just right and we were able to control the settlement with the addition of grout as in theory and the building itself is back to its old original location. However, right about Christmas time, through some routine maintenance, we determined that there was some deleterious material in the hydraulic system that protects the main bearings. We brought the manufacturer in and did some serious investigating and we determined that we were getting, at that time, what we thought was a seal failure in some fashion or another.

We made the conscious decision of having to take the head out. When we stopped at Christmas time, we were only about 30 feet outside the research center, so it wasn't a very good place to dig a shaft. Fortunately, Esso had an open spot in their yard about another couple meters so we moped along with reduced pressures in the chambers and that is what happens.

That fence was a straight line before we ran at reduced pressure. The necessity to balance the pressure is real. We did decide to dig a shaft design and we went to a design build with the contractor and the theory was that the clay was not stable enough to hold. The proposal that we got was to dig some concrete pilings down to give it enough stability so we could then excavate the clay and pull the head out of the shaft. This was supposed to take us

six weeks. It took us six months. This is why. That was the original design. We started asking the designer some questions. We started out with something like 78 piles and ended up with something like 264. So if you can imagine a 45-foot diameter circle filled with concrete 100 feet high, there is something like one million yards of concrete. This was great for the local industry. The idea was to drive the TBM into the shaft, remove the head, take it back to repair and drop it back down the shaft and resume mining. As the TBM entered the shaft just right at the outside they did experience a little bit of difficulty with the use of the jacks that went backwards and forwards. They actually dropped about a foot and a half and changed the alignment on the tunnel. That was part of the remedial work on the shaft, too. We had to knock out a bit of the concrete above the TBM and realign it and get going again. Now at the top of the shaft you can see the size of it is 110 feet deep. As we went down, we tied back with chain and foam to protect any debris from falling on the people. The concrete had to be removed. I don't know whether you can see it there, gentlemen, but there is a flattened surface on the can which is supposed to be circular and that is what happens when you use dynamite improperly. Fortunately, that did not have any impact on the delays as we were able to fix it.

On the Canadian side before we began any work was an old track back when they were running electric trains and diesels. There was also a single track and retaining wall type of construction to minimize the excavation.

This is more or less a finished product. We are now done with the grading on both the Canadian and American sides. That is the TBM as it is preparing the can itself. It is just going into the portal and you can see the trailing gear. It is about as long as a football field in its entirety. The can itself is only about 32 feet, I believe, but by the time you get the conveyor and the systems and the cars and all of the mechanical and electrical, it is about as long as a football field.

This is the A-frame where the muck trains deliver the muck. A crane hoists the muck car up and dumps it behind into a pit and loads it onto trucks and disappears to approved landfills.

This is just another shot of typical grade construction as we approach the tunnel. Here is the existing tunnel right now. There is the new one so I think it really gives you a sense of the difference in size of the two structures. If you are wondering what that is, this is exhaust for the air. The way they ventilate the tunnel is the fresh air comes down the tunnel itself and the stale air is exhausted from the front end machine and up and out through this muffled system to control noise. That is a bulkhead that we put in in case it becomes necessary to pressurize the tunnel.

We had some news that they had a very unfortunate incident over in Storebalt where the sea actually got into one tunnel, flooded, ran over into the second tunnel, and put both their tunnels out of service. Obviously we didn't want to take a new tunnel or our existing operation out of service so a bulkhead was installed. It is something that is 31 feet in diameter and is quite a structure in itself. It is to protect about three and a half bar pressure.

What I attempted to show there is when we weren't mining we were trying to catch up. You can see the new sidewalks are being completed on the left and they are being formed on the right here.

Up in this area is all the hydraulic and electrical. You can see the lights and we have about 25 percent of the tunnel completely finished. We are trying to make some catch up on the time we lost due to the shaft construction.

This is the muck coming out of the auger and dropping onto the conveyor system. If you mix it up and get it just like toothpaste, that's the ideal.

That's the first job we did on the American side. There was a crane runway there that had piles that went down directly through the path of the future tunnel so we had to go in and pull those piles, span them. That was actually our first job on the project.

Looking at the Port Huron approach from 16th Street, we had to lower that road about

seven feet with the new grades. As I mentioned to you earlier, the new tunnel descends toward the American side so you are quite a bit lower on the American side. In coming up, we had a maximum two percent grade. It was necessary to drop that road by about seven feet. Jim Anders is busily working with a couple of other railways doing the track work on the American side. The very funny clay there, as well as the top ten feet or so on the American side, was sand which we disposed of. The clay itself gets very greasy when it gets wet and then dries out just about as hard as rock. It was all taken out with trucks and backhoes. There was about 400,000 yards of grading on the American excavation.

We had to knock the back third of the building off as to allow the construction to proceed.

This is a shot of the American portal. In this area the portal is complete and there are piles there. Just when the TBM gets to the portal, the piles will be pulled and the TBM will be able to exit the situation. You can see we are more or less done on the American side now.

The sodding blankets prepared riprap for the catch basin. We had three inches of rain in an hour about two months ago that flooded right up to the top of the retaining wall and those weren't permanent pumps. It's a one in 100 year storm so that it is not going to happen again, but that's what can happen to you when you are planning. That is looking from the American side back up over to the 16th street. As I mentioned before, there is a bit of an alignment that you may not be able to pick out there. There are reverse 30 curves that get us back into the existing alignment just beyond 16th street. With any luck at all, we will beat those damn mules after all.

We started mining again at the first of the month with a bunch of new people. We felt there would be a learning curve and the statistics of the tunnel drive was such that we hoped to average about six rings a day. On Saturday, we got ten rings and on Sunday we got twelve rings. We are not going to get that every day but we are hoping to gain back some time if everything goes well under the river.

If it does go well, in the spring of next year that is what you will see. Gentlemen, that is the end of the presentation.

Member: How much do you have left to go?

Mr. MacLennan: We had about 25 percent of the tunnel done when we were stopped, so we are just going under the river. We will be going under the river within a couple of weeks. How it works is about a third under the river and one third back up.

Member: Why did you get stopped?

Mr. MacLennan: In hindsight what happened is that 32-foot head started to flex. It wasn't stiff enough or the pressure was too great or whatever. That is still being analyzed. When it flexed, it impacted the seals obviously more than their tolerances and destroyed the seals. We had no barrier at all from sand or clay coming into the hydraulic system. In hindsight we would have never made it under the river. So the decision to pull ahead even though it ended up taking us longer, was the right decision.

I thank you very much for having us here and hopefully next year we will be able to come back with a video that is enlightening and show you the first train going through the tunnel. Thank you very much. (Applause)

Mr. Koff: We are going to give Mr. MacLennan one of our soon to be famous coffee cups as a little token of our appreciation. We thank you so much for coming down and spending a little of your time with us.

Mr. MacLennan: Thank you.

Mr. Koff: I especially appreciated that topic. It was one of ours in St. Louis and if you remember that was our first year where we did the surveys. One of the comments that we got back in pretty strong numbers was that they would like to hear an update on this tunnel project so we fulfilled that. I hope you enjoyed it and I am sure it met your expectations. It was a very interesting project.

PANEL DISCUSSION

SAFETY

Moderator: Richard K. Reynolds, Union Pacific

Panelists: L. Ross, Burlington Northern
M. Mitchell, Norfolk Southern
J.L. Cashwell, CSX Transportation
M.D. Simmons, Florida East Coast Railroad

Mr. Koff: Our next presentation is a panel discussion on safety. There are some common things on all of our roads in regards to safety programs and there are some things that some roads are doing differently. This is a chance to learn about both of those.

We are very pleased to have Richard Reynolds here today from the Union Pacific Railroad. Mr. Reynolds volunteered to be our moderator and chairman of this panel discussion. He is director of safety for engineering services for the Union Pacific Railroad headquartered in Omaha. He started his career in January, 1970, with the Missouri Pacific as a trackman. He has held various positions including machine operator, work equipment mechanic, assistant roadmaster, manager maintenance of way equipment, and manager of safety and engineering services.

He is a member of Roadmasters and Maintenance of Way Association, American Railway Bridge and Building Association, AREA, and American Society of Safety Engineers. He is very well qualified to be here with us today so please join me in welcoming him. (Applause)

Mr. Reynolds: Good morning. We thank you for the opportunity to speak to you about safety this morning. Our committee subject was selected by the Roadmasters executive committee and it is safety.

Safety is the most important part of any maintenance-of-way operation. This committee will examine the railroad maintenance-of-way programs and practices from the following four railroads: CSX Transportation, Burlington Northern Railroad, Florida East Coast Railroad, and the Norfolk Southern Railway.

Each of the four gentlemen on this panel will give their presentation and then we will have a question and answer session at the end. If you hear anything that you want to ask questions about during the presentation, please jot it down so we can share those as we finish. We will begin with Jim Cashwell, engineering director of safety, CSX transportation. Mr. Cashwell is a 26 year employee of the CSX and predecessor companies. He has served and filled positions from assistant roadmaster through division engineer.

Mr. Cashwell: Thank you, Richard. Good morning everyone. I am pleased to represent CSX and its employees and our safety process as part of today's panel discussion on safety. We at CSX recognize the outstanding record that the rail industry, as a whole, has achieved and we applaud the continuing improvement in public safety issues, train accidents, and prevention as well as personal injury reduction that we see taking place everywhere.

Overall, we at CSX have reduced reportable injuries by 74 percent since the late 1980s. Our eye injuries have been reduced 91 percent. Foot and ankle injuries have been reduced by 78 percent, and back injuries are down 74 percent. Our reduction in engineering injuries has paralleled the rest of the company as we have reduced injuries by 70 percent since 1989.

The 1994 year-to-date performance is in the position of a 26 percent reduction in reportable injuries. As we all know, the three main ingredients of all engineering activities are safety, quality, and cost effectiveness, but it all starts with safety. Everyone throughout our organization is committed to creating the safest work environment possible. Employee safety is technically a line manager's responsibility, but everybody within our organization is expected to find a way to have an impact on the safety process.

As an example, those in the staff positions can expect an assignment of a safety partner or godfather to a division shop or production team. We believe that ownership in the process by employees from all levels of our organization is what makes the process really work best. We also are absolutely convinced that quality and productivity are not in competition with safety.

As our safety performance has improved, so has our quality without sacrificing our cost concerns. Some of the components we consider vital to our safety process include a visible and consistent management commitment to safety. The centerpiece of this effort is an overlapping safety committee process. Each month the safety steering committee chaired by the executive vice-president and chief operating officer, Jerry Davis, meets with his direct reports such as vice-president engineering, Tom Schmidt, and the other department heads and key staff members. These meetings are conducted at different field locations and are attended by the local safety committees and the local managers.

This is a typical general agenda of those monthly meetings highlighted by employees of the local facility. Following these meetings, each manager and each department head promptly holds an overlapping meeting with their direct reports and so on and on until each employee has the opportunity to attend a meeting every month. This process encourages open communication up and down our organization structure.

At CSX we are committed to being the safest railroad possible and we believe that an important component in accomplishing this is empowering our employees with the right, the responsibility, and the resources to make safe decisions. Employees are expected to make decisions based on their training, experience, and personal judgment. A reoccurring theme is that if it can't be done safely, don't do it.

Since CSX is comprised of several former properties, each of which had their own rules and procedures as well as their own unique history and culture, re-thinking our safety rules was extremely important. This process was undertaken and accomplished by the employees themselves. In April, 1993, CSX adopted their new rule book called the CSX Safe Way. This rule book contains only 27 rules along with recognized and mandatory procedures. These changes replace 930 outdated rules which, in many cases, appeared to some of our employees as existing primarily to run people off. The new rules reinforce empowerment to employees while emphasizing the rights and responsibilities to make safe decisions.

At CSX we truly believe that no job is so important and no service so urgent that we cannot take the time to perform work safely. We are committed to providing adequate training opportunities for all employees. The education and training offered our employees covers a full range of options from college tuition rebates to a variety of personal development, technical, and safety training opportunities which include those listed on the screen.

Some highlights of our training are safety certification. Safety certification has become an annual training vehicle used by all departments at CSX to refocus on basic safety issues. Certification is typically a two-day session that is geared to employee training. The focus is on safety rules and procedures with additional modules designed to address specific needs within the department. In 1994, certifications covered topics as varied as FRA fall protection, basic chain saw safety, defensive driving, pinch point injuries, environmental awareness training, hi-rail safety and back injury prevention training. In addition, employees were given health screenings which included blood pressure and cholesterol training as well as a hearing and a pulmonary function test.

In the mid 1980s, we began to focus on reducing back injuries by teaching proper lifting techniques. This training has proven beneficial, but back injuries continue to represent the largest percentage of injuries. In the late 1980s, we made back support belts available to our employees. We later introduced a program of on-the-job exercises to encourage our employees to warm up their muscles before beginning work activities.

In 1992, we met with Dr. Richard Bunch who is the associate professor of industrial safety and rehabilitation at L.S.U. Working in concert with Dr. Bunch we have developed a

more comprehensive program we call, "Back In Motion." This program reinforces the importance of proper lifting techniques and work procedures and also encourages the use of back support belts. "Back In Motion" embraces the responsibility of employees taking personal responsibility for their own fitness and emphasizes the importance of stretching and exercise both on and off the job. Our goal is to educate our employees to the fact that most back injuries are preventable. We also believe that most back injuries are not the result of a single event, but are the cumulative result of lifestyle and lifting habits on and off the job. It is our belief that most of our back problems can be prevented by taking a proactive approach.

At CSX we have a job briefing procedure which requires that before any task be undertaken, the work force involved meets and discusses in detail the job to be performed. They should discuss any and all hazards involved, review the applicable safety rules, and discuss the tools, equipment, and personal protective equipment required. We must also consider the effects of current weather conditions as well as team and individual assignments. Additional or follow-up briefings are required as a job progresses or as conditions change.

Our employees are our greatest resource and therefore if we are to reach our potential in safety, service or any of the other areas of performance, we need the involvement and support of all of our employees. Employee participation is a vital ingredient of our safety effort. The engineering department has a system safety committee of contract employees that has been instrumental in our overall improvement in reducing injuries. This team is comprised of employees from all parts of our property and represents every function within engineering. They are involved in the training, safety assessment, and programs developed in addition to providing pure leadership. They also provide advice and counsel at every level of our organization as well as important field support. Our engineering department is relying more and more on our contract employees and safety committees for leadership in both developing and facilitating programs as well as managing committees and promotional activities. One successful employee-led program is our Blue Head program which is to reduce switch-related injuries and derailments by assigning specially trained switch maintenance employees in yard and terminal areas. We have also a Green Head program which allocates safety representatives to every active engineering gang.

Another of our programs is the Summer Spike Program. This program grew out of our concern over the dramatic increase in injuries that we have experienced every summer. After analyzing these injuries, it became clear that every department and every craft was affected by this summertime increase in injuries. We assembled a team of contract employees to review injury data, interview medical and wellness specialists and review our work practices. From these efforts we concluded that we must target specific issues such as educating our employees on heat stress. Having them focus on avoiding mental vacations, facing work activities appropriately to the conditions, scheduling work in the coolest part of the day, and alternating employees on physically demanding tasks. We emphasize nutrition issues and making sure that plenty of cool water is always available. Taking appropriate breaks is also emphasized. This training was delivered through safety meetings, videos, tailgate lectures, newsletters and home mailings. This message was reinforced daily through job briefing, posters, and safety bulletins.

In 1993, we reduced summer spike injuries by 45 percent. In 1994, results are an additional 38 percent improvement over 1993. As we have re-engineered our work force, we have also looked for opportunities to reduce injuries by finding better ways to accomplish our work and reduce the exposure to our employees.

Some of those changes are in our basic forces. They are now equipped with power tools. We have more and better truck mounted cranes and better designed vehicles. We have radio-controlled ballast cars in our ballast trains and air-conditioned pressurized ballast regulators. We have improved radio communications and communications equipment. We have made many safety modifications to our production equipment. Our material is packaged in more user-friendly sizes. We have made improvements to personal protective equipment.

A combination of all of the items that we have discussed represents a virtual change in our CSX culture. Some of the items that I might mention that have also impacted that paradigm shift would be that we replaced camp cars with motel lodging. We have frequent "let's talk" sessions with our employees in order to improve communications. We have engineering quarterly news videos and newsletters available for our employees.

These are the primary elements of our safety process in the engineering department at CSX. We all know that everything we do is safety related and we must continue to explore and probe in the search for improvement wherever they may be.

Thank you very much. (Applause)

Mr. Reynolds: Thank you, Jim. Next we have Lane Ross. Lane has been a roadmaster for the last 10 years with the Burlington Northern Railroad and is currently headquartered in Dickinson, North Dakota. Mr. Ross started with the Burlington Northern as a laborer in a roundhouse in 1976. He transferred to the maintenance-of-way department in 1977 as a track welder. He supervised track gangs from 1979 until promoted to his present job as roadmaster.

Mr. Ross: Good morning ladies and gentlemen. The following presentation represents Burlington Northern Railroad's safety commitment to both its employees and the commitment by the employees to remain injury free.

Safety is the most important responsibility of any official of the Burlington Northern. Personally, there is nothing in my work that receives equal time or effort to accomplish this important goal.

The graph displayed now shows the Burlington Northern had the worst safety record of all the Class I railroads. In 1991, we had almost twice the casualty ratio of the Union Pacific and seven times that of the Norfolk Southern who was the industry leader. We had a serious problem that required immediate attention.

To our disgrace, we did not address the issues immediately. In 1992, we only improved a miserable 1.5 injury per every 200,000 man-hours worked. For the years between 1987 and 1993, we consistently had the worst carrier injury rate in the industry. In 1992, it was recognized by top management that this problem must be addressed. We could no longer let this situation be an acceptable part of doing business. The cost both at a personal level and from a financial point of view left us no alternative. We were faced with changing both our priorities and direction towards the future of our railroad.

This slide shows the policy and direction our company was to take.

First, we are committed to providing a safe work environment for all our employees. It is management's responsibility to make all changes possible to eliminate any known hazards in the workplace.

Second, we believe that the safe performance of the job is always more important than the job itself. Simply put, this tells all our employees if it can't be done without hurting someone, don't do it. This policy in itself makes the employee responsible for his actions and the results occurring from them.

Third, we will provide the training, tools, and resources required to ensure a safe and clean workplace.

A very strong statement for this is, if a supervisor cannot manage to have good housekeeping in his work area, he cannot manage his workforce. Employees should also be given responsibilities in line with their abilities. The more training we provide, the more we can expect from our employees.

Fourth, and the most important, employees are empowered and required to discontinue any activity that involves the use of unsafe practices or tools. This one statement caused plenty of heartburn for the firstline supervision because we felt it gave any employee the right to refuse service by taking advantage of the principle. Actually, we worried more about this issue than necessary. It was seldom abused. We cannot expect our people to make sound judgment decisions regarding safety or any other matter without giving these same employ-

ees the power to stop an act which they feel could possibly endanger their work unit. The worry and heartburn disappeared once we relearned the fact that when you treat an employee like they will have common sense and commitment, that is what they will produce.

After we supervisors digested the new principles of our company, we were ready for a new philosophy. These principles are as follows:

All injuries are preventable. Therefore, no injury is acceptable. This seems to be common sense; however, the simple idea shook the long-conditioned mindset that things happen. Now someone had to be held accountable because it was no longer acceptable for the theory that accidents just happen. Out of all the training from Dupont this was probably their hardest fought point to get across. Now looking back, Dupont was correct. They were fighting a frame of mind that our industry could no longer afford.

Working safely is a condition of employment. This idea is still being tested by both the organizations and the carriers. There does seem to be a number of awards coming back that agree with this responsibility issue for both the railroads and the employee. A portion of providing a safe working environment would dictate that if an employee is hazardous to himself or others, he should be removed just as any other physical hazard would be.

All employees are responsible for their own safety and the safety of their co-workers. Safety and teamwork must be based on responsibility and trust within the work group. Management at all levels is accountable for the safety of the employees working for them.

With this, all goals for every official of Burlington Northern were drastically changed. We now had the commitment of top management to reduce our injury rate by 50 percent in 1993 and again by 50 percent in 1994. To our credit, the 1993 goal was reached and 1994 looks attainable. If you would have asked almost any firstline supervisor in 1992 how he or she felt about these goals, you would have heard that it was impossible to achieve.

We accomplished this goal through some of the most extraordinary weather in years to the credit of our employees. Scheduling and production goals became secondary. That made this commitment by top management self-evident.

This safety policy will be implemented through the application of Burlington Northern's four principles of safety. The last statement returns all focus back to the original principles.

The role of a line supervisor places us in a unique position of trust. Not only does the company rely on us as a direct representative of management to apply its policies wisely and fairly, but also entrusted to us is the obligation to safeguard the well-being of the workers in our charge. No responsibility transcends this in importance.

As a supervisor, you are indeed your brother's keeper. On-the-job accidents represent a serious threat to the well-being of your people. Accident prevention calls for your constant vigilance. Therefore, if you will guide your people safely through their daily work, you will also be guided by these precepts.

You are the supervisor and thus in a sense have two families. Care for your people at work as you would care for your people at home. Be sure each of your people understands and accepts his personal responsibility for safety. Know the rules of safety that apply to the work you supervise. Never let it be said that one of your people was injured because you were not aware of the precautions required for the job.

Anticipate the risks that may arise from changes in equipment or methods. Make use of the expert safety advice that is available to help you guard against such new hazards. Encourage your people to discuss with you the hazards of their work. No job should proceed where a question of safety remains unanswered. When you are receptive to the ideas of your workers, you tap a source of first-hand knowledge that will help you prevent needless loss and suffering.

Instruct your people to work safely just as you would guide and counsel your family at home with persistence and patience. Follow up your instructions consistently. See to it that workers make use of the safeguards provided them. If necessary, enforce safety rules with

disciplinary action. Do not fail the company which has sanctioned these rules or your people who need them.

Set a good example. Demonstrate safety in your own work habits and personal conduct. Do not appear as a hypocrite in the eyes of your people. Investigate and analyze every accident, however slight, that befalls any of your people. Where minor injuries go unheeded, crippling accidents may later strike.

Cooperate fully with those in the organization who are actively concerned with employee safety. The dedicated purpose is to keep your people fully able and on the job and to cut down the heavy personal toll of accidents. Remember, not only does accident prevention reduce human suffering and loss, but from a practical viewpoint, it is simply good business. Safety is one of your prime obligations to your company, your fellow managers, and your fellow workers. By leading your people into thinking safely as well as working safely every day, you will win their loyal support and cooperation. More than that, you will gain in personal stature. Good people do good work for a good leader.

At Burlington Northern, we have an agreement with Johnson County Community College in Overland Park, Kansas. This is referred to as the technical training center. Classes range from engineer certification, dispatcher training, thermite welding, to machine operation and servicing for the maintenance of way. All classes stress the safety issues before any others. We have extensive in-the-field training. Some of these classes consist of back injury prevention, respirator training, HazMat and HazCom, just to name a few.

I am from the Yellowstone Division of Burlington Northern. On our division, we investigate every incident whether it is reportable or not. This is a formal investigation with organization representatives present. Most investigations end with a letter thanking the individual for his participation and suggestions. Some do end with disciplinary action. We feel this is the best approach and it is consistent throughout the various crafts. It is my understanding that many other divisions across our road are now following these same procedures. It has been my experience that when we investigate injuries and hold individuals responsible, the injury rate goes down. Statistics shown at the start of this presentation clearly show that.

In closing, I would like to thank the Roadmasters Association for this opportunity to share just a few of Burlington Northern's ideas and policies regarding safety. There is nothing more important in our workplace than the security and safety of the people we work with. Having the pride of being the safest carrier in the industry is a goal that is achievable and Burlington Northern is striving to become number one.

Thank you for your attention. (Applause)

Mr. Reynolds: Thank you, Lane. Our next speaker will be Mark Simmons, superintendent of rules on Florida East Coast Railroad headquartered in St. Augustine, Florida. Mr. Simmons was hired by the Florida East Coast in 1979 in a switchman's position working as a contract employee qualifying in all transportation crafts through 1985. He assumed a manager's position in 1985 as assistant terminal trainmaster in Miami, Florida. In 1990, he moved into the safety field as assistant to the safety superintendent with headquarters in Miami. In 1992, he was promoted to superintendent of safety and rules, moving his headquarters to the general offices of the Florida East Coast Railroad located in St. Augustine and still holds that position. Mark.

Mr. Simmons: Good morning, ladies and gentlemen. On behalf of the management and myself of Florida East Coast, I would like to thank you for giving me the opportunity to come and speak to you today. After hanging on the phone with Ken Johnson and agreeing to be one of the panelist in today's group, I asked myself what kind of program would I be able to present after our poor safety performance in 1993.

I certainly did not have a success story to highlight and, in fact, I thought this could be quite embarrassing. After reflecting for a while I realized there might be safety programs in the same situation after having many years of success, and then realizing that change was

necessary as programs become obsolete. I realized I should speak on our successes and improvements that we have seen with the changes that we are currently putting into place. Even though the statistics are still fresh and may not represent the success of the program as a whole, we do feel that we have made progress and that we are on the right track.

For over 20 years, the Florida East Coast placed consistently in the highest awards categories among competitors for the annual Harriman awards. In 1993, we reported an all time high of 60 personal injuries. We were asking ourselves where were these injuries occurring and why. However, we are proud that for the first six months of 1994, FEC has successfully reduced the number of total injuries by 23 percent. Also, our lost time days have decreased from 943 in 1993 to just 613 in 1994.

Individually, our maintenance-of-way departments have also shown a substantial reduction in 1994 of over 80 percent for the first six months reporting only one personal injury through July, 1994. The signal communications department has successfully completed 18 months without a reportable injury and we are very encouraged.

It was clear that there was trouble within the safety program and the usual course of placing blame and fingerprinting by parties involved did not help to find a solution. Even after a long, detailed look into the patterns and trends, no divine cause could be determined. It did seem, however, to be somehow linked with our previous administration's policies and discipline procedures. The previous administration had a rule-driven safety program where responsibility for injuries was placed directly on the employees involved. Those employees who were found to be at fault were strictly disciplined for their actions. We found ourselves realizing that injuries may have not been reported for fear of disciplinary action and under the new administration's policy, these injuries were now being reported and as a result we had our 1993's record increase.

The open communication under our new management stresses the reporting of all injuries with the philosophy that until we know where the problems really are, they cannot be properly addressed. But how were we to properly address the areas that needed attention or upgrading when the injury trends were not apparent or the statistics had been distorted? This put extra pressure on our safety staff to address these injuries that were now being reported. It was time to act.

Trying to pinpoint the reason for the escalating injury rate was no easy task. Open communication and surveying employees brought to light issues such as employee participation, poor attitude, and boredom with repetitive programs. These were only some of the complaints that we received. Although it is too early to tell, we have made many changes in response to these common indications. It was clear that a review of the safety program at Florida East Coast and management techniques was desperately needed.

We believe that our quality process has led us in a new direction for managing the safety program. The "Fast Track to Quality" was introduced to the management under the new administration's leadership. The safety program was the first to truly utilize the Fast Track to Quality Management, the process for improvement with its development of key strategies for improvement.

The first was to develop the employee safety committee. When we began to get our people directly involved in the decision-making process and listened to their input on safety concerns, it greatly heightened their awareness and participation of overall safety. The employee safety committee's vision is to work together for the benefit of our future. This committee is staffed totally by contract employees representing all crafts.

These volunteers were charged with developing the committees charter bylaws. They performed an outstanding job in developing the program with these clear objectives and purposes. They were drawn up and agreed to by management and placed into effect immediately.

The Employees Safety Committee program has been an extremely important part of our success so far. The ESC will lead in the following steps in our strategy for improvement.

Their input into these programs has been essential to their development. The employee safety committee has also been a guide post for other teams to learn from in projects where employees input and participation was needed.

The next step in the key strategy was to use the employee safety committee in the development of our written safety program. This is a statement demonstrating a commitment to an employee driven process for safety and will be used by managers, supervisors, and contract employees to serve as a guide and information source that will be continually updated.

Some of the key points are:

- Vision statement.
- Goals.
- Functional elements.
- Special programs.
- Safety tasks.

Finally, the third key strategy is a management steering committee, which set forth a quality team to develop an employee training program that would address ongoing development programs for all crafts. This group was also eager to bring in the employee safety committee as consultants for technical aspects of the curriculum as these employees know their jobs first hand and have expertise in each area.

Some of the key points in this training program include:

- New employee orientation.
- Introduction to safety.
- Resource and information package.
- Ongoing training program for all crafts including management skills.

This project is ongoing. Following are some ideas that have been specifically developed for the maintenance-of-way program:

- Safety orientation.
- Semi-annual safety training.
- Daily safety talks and job briefings.
- Safety incentive program.
- Recognition of safety achievements.
- Employee safety committee accident follow up.

Even though it is too early to tell how successful these strategies will be, we are certain they could not have been developed without the input and expertise of the employees involved in our safety committee programs.

I cannot stress to you and your companies enough what a wealth of knowledge and resources are waiting to be tapped into by letting your employees be involved in decision making and program development. This gives them a feeling of accomplishment and greatly heightens their awareness. Ask yourselves, who know what works better than the man on the line performing each task? By listening to them as you change and progress for the future, it will greatly improve your safety program.

We at the Florida East Coast feel we have found the answer to our safety concerns by empowering and utilizing the wealth of knowledge and expertise of our employees. We believe that we are on the fast track to safety and quality and our safety record will prove it.

Thank you. (Applause)

Mr. Reynolds: Thank you, Mark. Our last presenter this morning is Max Mitchell. He is presently manager of procedures and training with the Norfolk Southern, headquartered in Atlanta, Georgia. Mr. Mitchell began his railroad service in 1964 as a summer student on the Southern Railway. He graduated in 1968 from Clemson University with a B.S. in agricultural engineering.

He served in the United States Army from 1968 to 1970 with a tour of duty in Vietnam from September 1969 to September 1970. Mr. Mitchell returned to full-time service with the Southern Railway in November, 1970. He has held positions as track supervisor, assistant division engineer, superintendent of safety, maintenance of way and signal, division engineer, procedures and joint facility engineer, and is presently manager of procedures and training.

Mr. Mitchell: Thank you. I am pleased to be able to represent the Norfolk Southern today. The successes I am about to discuss have been accomplished by our employees with the commitment that our management has provided.

Ever since I first stepped foot on the railroad some 30 years ago, I was told that safety is of the first importance in the discharge of duty. From what I have seen, that sentence has been the opening statement in the general notice of every railroad's book of operating rules for many years. While all of us old heads can relate to that language, we all realize that for many years it was often lip service. I recall going to a class given by our personnel department on how to fill out employee evaluations. In this class we were told to list in priority order criteria by which we should evaluate our subordinates. I listed safety as number one and knowledge of adherence to operating rules as number two. I was told that these items could not be items one and two priorities because they were not the most important parts of an employee's job. I further recall quoting the first sentence of the general notice and then was further admonished for being a smart aleck and that safety and knowledge and adherence of the operating rules definitely were not number one and two items to evaluate our employees on. If they were to be considered at all, they would maybe be at the bottom of the list.

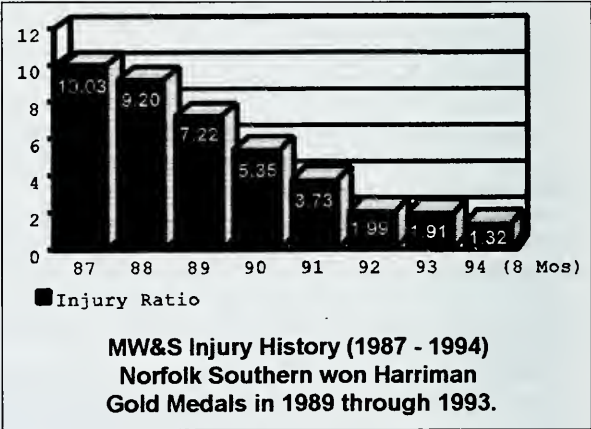
Fortunately, not only has my railroad come a long way since those days but most of the industry has made great strides of truly making safety the first response in the discharge of duty. Safety is no longer just given lip service. It is now a way of life. This process is not over. We still have a long way to go.

But Norfolk Southern is now on the right track. Norfolk Southern won the Harriman gold medal in 1989 and we have continued winning it for an unprecedented five consecutive years. Simply put, safety is good business.

How did we get there? Even though Norfolk Southern had what one would consider a respectable performance, as indicated by winning several Harriman medals, our management was not satisfied.

In 1988, we retained the Dupont Safety Consultants to evaluate our existing programs and make recommendations. Two primary recommendations beyond what we were already doing were made by Dupont. The first was that our people from the very top to the very bottom needed to be more involved with the safety process. The second was that we should make our safety audits more structured and focus on the actions of employees rather than the conditions.

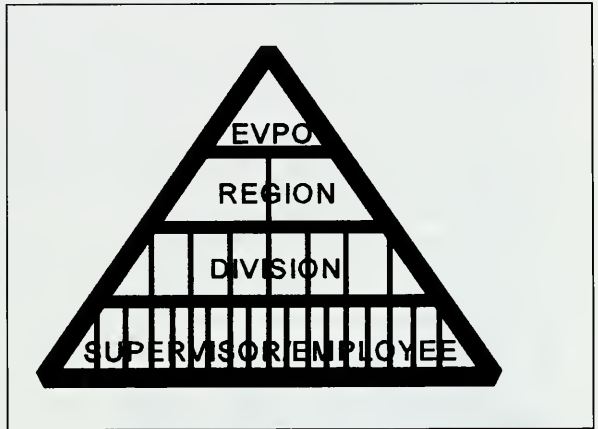
Our safety structure was examined and new committees established. If safety is not given priority from the top of an organization, it cannot be truly successful. To make this begin from the top, an executive vice-president operations steering committee was established. This committee is chaired by our executive vice-president operations who is our chief



operating officer. This committee is now known as the operations division safety steering committee. It is made up of other senior management and meets monthly. This committee does not remain in its ivory tower, but meets at different locations in the field.

Following this meeting, an AVPO committee conducts an audit of the facility at the meeting location regardless of where the particular meeting was held. We also have two regional safety steering committees. One for the eastern half of the railroad and one for the western half. This committee is composed of upper middle management with the chairmanship rotating annually between maintenance of way and structures, mechanical, and transportation.

Next are our division safety steering committees which are again comprised of all departments on the division with a chairmanship rotating between the division superintendent, the division engineer, and the master mechanic. In order to better facilitate communications, the chairmanship of the regional committee and the division committee should be from the same department. We then have a supervisor of employee safety committees at the local level. While this may appear to be a considerable bureaucracy of committees, each committee has its own distinct function. Each committee does not operate in a vacuum, but rather operates in tandem with one another with an active flow of information both up and down. Through this process, the commitment of senior management is communicated to all employees at all levels. Senior management meets monthly to make the necessary decisions required regarding policy, direction, et cetera.



In 1990, Norfolk Southern also recognized, as much of corporate America has done, that in order to retain and broaden our customer base, we must formalize our quality process. Rather than reinvent the wheel, we again looked at other companies and enlisted the 3M Company to help develop our Thoroughbred Quality process. While Thoroughbred Quality is another story entirely, one thing that we learned is that if our safety process is to be actually successful, it must incorporate the quality process. Safety and quality go hand in hand. We learned to empower our employees.

In July of 1989, our executive vice-president of operations, P.R. Rudder, issued a statement of policy for safety to all personnel outlining in detail the procedures to enhance our safety process. It was most recently revised effective January 1, 1994. Page one presents our six tenets or statements which we are expected to internalize and follow.

Our statement of policy is as follows: the Norfolk Southern Corporation is committed to the principle that safety is good business. No one should be exposed to unnecessary hazards and risks. Responsibility for safety cannot be transferred. Each employee of this corporation therefore is held personally accountable for his or her action on the job.

1. All injuries can be prevented.
2. All exposures can be safeguarded.
3. Prevention of injuries and accidents is the responsibility of each employee.
4. Training is essential for good safety performance.

5. Safety is a condition of employment.

6. Safety is good business.

One of the most important steps in getting any job done is to set goals with measurable criteria for determining whether the goals are met. Each year, corporate goals are set by the operations division safety steering committee. Each major department then adopts these goals or uses them as guidelines for more stringent department goals.

Five goals are set by the MW&S department for 1994. They are:

1. Zero fatalities. This goal is always our number one goal. Each employee is a valued part of the Norfolk Southern process and even though every position may host a number of different faces, each employee brings to his or her position experience and expertise which is uniquely his or hers. Put simply, to replace an employee is expensive in terms of cost and experience.
2. Reduce FRA reportable injuries by 15 percent. In 1993, we reported 97 injuries. In 1994, our goal is to have fewer than 82 reportable injuries. In 1987, we experienced 535 injuries. Through 1993, reportable injuries decreased 82 percent since that time.
3. Reduce injury incidents by 25 percent. In 1992, we had 266 injury incidents. In 1993, we had 260, which is an improvement of only two percent. We know that if we don't stop underlying instances we will not be able to decrease our FRA reportable injuries. Remember tenets No. 1 and No. 2, that all injuries can be prevented and all exposure can be safeguarded. Consequently, our goal for 1994 is proportionally higher with the expectation that meeting this goal will put our rate of improvement back on track.
4. Reduce reportable back injuries by 20 percent. Back injuries typically account for 35 to 40 percent of total injuries, a healthy, or unhealthy as it were, chunk of the total incidents. They tend to be the most debilitating injuries and recovery is often both long and slow.
5. Reduce highway vehicle accidents by 20 percent. While highway vehicle accidents are usually minor and produce only nonreportable injuries, they hold the potential not only for serious injury but for fatalities as well. A highway vehicle is like a cocked gun waiting for a lapse in concentration to fire. In 1993, our highway vehicle accidents jumped from 66 in 1992 to 87 for an increase of 32 percent. We were appalled by this increase and realized how damaging that increase can be. We also realized how vital it is that this lapse be corrected.

Once goals are set, performance must be monitored frequently and consistently. Procedures for receiving quick feedback from throughout the department were established to determine how well goals are being met. You must be able to determine how many accidents have occurred and what type of accidents are occurring.

As of the end of August, our MW&S department had no fatalities. We have reduced FRA reportable injuries 41 percent and have reduced total injury incidents by 50 percent compared to the same period in 1993. We are certainly meeting our goals and, more importantly, exceeding our goals. Most of all though, this improvement translates into less pain, suffering, and anguish for our employees and their families.

Another indicator of our success is the number of supervisors in the engineering department who have had no reportable injuries under their jurisdiction during the calendar year. In 1989, our first Harriman gold medal year in the string of five, we had 125 supervisors with no reportable injuries. Last year in 1993, we had 309 supervisors and this is from a smaller pool than in 1989 that had no reportable injuries.

Nothing can be gained by repeating mistakes. Likewise, where one technique or application improves safety performance, that technique or application deserves to be shared. Training therefore becomes an integral part of our safety process. In fact, safety is an integral part of all training whether it be formal training conducted locally or at our training center at

McDonough, Georgia, or informal training that we conduct trackside.

When an individual receives training for a job, they are taught the safety rules, the correct job procedures, and applicable safeguards. They are trained to recognize the hazards associated with their jobs. In knowing those hazards, they are less likely to assume the risks and endanger not only their own welfare but also that of others. Remember, every employee is held accountable for his or her actions on the job.

Norfolk Southern through its training programs takes responsibility for training its employees to do the job safely. In addition to the safety training, all employees whose duties are prescribed under the operating rules are trained regularly and are required to take an annual safety and operating rules examination.

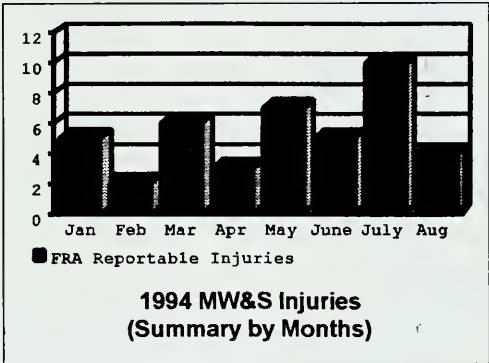
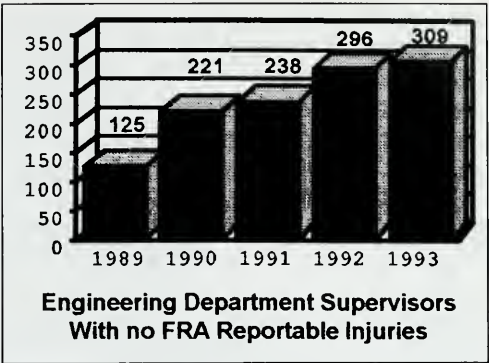
Each spring, Norfolk Southern conducts hot weather meetings to reemphasize guidelines for trackwork during the hot weather months. Safety leads the program and is heavily emphasized in these training sessions. We use these meetings each spring to remind our employees that safety includes not only safety of train and equipment operations, but personal safety both on and off the job. Our yearly evaluations demonstrate a disturbing relationship between the summer months and the number of injuries. We call this relationship the summer spike because during the summer the number of injuries increases. We commend CSX with their summer spike success. However, as much as we have tried, we have not stopped this. We spiked with ten injuries in July.

Frequent regular safety audits of work practices are conducted to determine violations that need correcting and improvements that need to be made. Daily observations by co-workers, foremen, and management of employee work practices during the course of normal work activities are a valuable tool for evaluating the employee performance and correcting deficiencies. In addition, each failed supervisor must take a weekly safety audit on work habits and work practices. In most instances, a scheduled employee assists the supervisor with the audit. The results of these audits are recorded and retained on file for two years.

Safety violations are addressed immediately through instruction or demonstrations and the employee is given the opportunity to demonstrate his understanding of the correct procedures. However, discipline is generally not applied except in cases of Rule G violations, serious negligence, or persistent unsafe work practices.

Communication between the committees and the employees they represent as well as between the supervisory levels and the rank and file must be established and maintained for this process to be successful. All personnel are encouraged to participate actively and join in all aspects of the process from setting safety goals to safety audits.

Materials promoting safety awareness are readily available. The emphasis we place on



safety must be visible in the examples we set and in the banners, posters, and safety materials we distribute. To ensure some amount of regular communication, each supervisor must initiate quarterly at least one personal recorded one-to-one safety contact with each of his employees. These contacts will provide safety reinforcement and an opportunity to check on understanding of safety practices and will emphasize the concern for the general health, welfare, and safety of the employees. Note that this quarterly contact is a required minimum. Safety doesn't happen as a result of the quarterly contact. It must be lived and practiced daily. Each morning at the beginning of work we take a few moments for warm-up exercises. Each Monday morning we hold short safety meetings to discuss the work anticipated for the week and any other particular matters and the concerns that are passed down as well as those raised locally.

On one day in January of this year with the exception of any operations emergency, we had a 100 percent stand down and addressed safety related matters and concerns. Additionally, we hold cookouts from time to time to recognize our people. During the winter holiday season, we hold safety dinner meetings throughout the railroad and invite the spouses. Repeated exposures to the message of safety represents basic stepping stones for the development of morale, enthusiasm, and interest. Every two months we mail a departmental newsletter we call *The Right Track* to the employees' homes. This newsletter recognizes individual employee performance, individual gang performance, as well as other activities. At a corporate level, Norfolk Southern subscribes to the *Family Life* magazine for all of its employees.

The safety process must be rigorously and consistently enforced. Safety audits are conducted frequently as stated previously. Individual employees are held personally accountable for safety performance. Even so, safety auditors are not hounds on the trail of the hare. Quotas for finding rule violations, employee harassment and so forth are not tolerated.

Discipline aims at prevention and training. Rules compliance is encouraged and corrective action is taken only when necessary. When an accident occurs, the need for medical attention is ascertained immediately by the line supervisor and is obtained when necessary or is requested. When transport to a medical facility is required, the line supervisor or his representative accompanies the injured person to the facilities. Emergency room personnel or the doctor is informed that an on-duty injury is involved.

Following an accident, an investigation is initiated to determine the cause of the accident. An accident indicates a breakdown in equipment, work environment, or personnel and that breakdown must be discovered and corrected, equipment must be repaired, but the investigation must also determine the frequency of similar malfunctions. Training is reevaluated and work environments are corrected as required to avoid a reoccurrence of the incident. Finally, dwelling on the negative sabotages morale.

People tend to repeat things for which they are rewarded and safety is certainly no exception. On-time performance is stressed and personnel who meet tight production schedules are praised. But safety must be emphasized over and above all else. No job is so important and no service is so urgent that we cannot take the time to perform our work safely.

How many of you would want to be the messenger that delivers the news to a co-worker's family that their father, husband, wife, mother, or sibling was killed on the job because you were trying to meet a deadline? That thought gives the word "deadline" an ominous meaning, doesn't it?

Recognize and reward safety improvement and accident free performance. Commend individuals and groups that contribute to the process of success. Involve employees and their families and encourage safety both on and off the job.

Safety is now a way of life and truly the first importance in the discharge of duty at Norfolk Southern. While for many years we talked the talk, we now walk the walk that no job is so important and no service is so urgent that we cannot take the time to perform our work safely.

We are not where we should be. We are not where we are going to be. We are not where we ought to be. But, thank goodness, we are not where we used to be.

As we look at this closing slide, one generally thinks of that as being the end of the day and riding off into the sunset. However, our safety is not at an end. Let's look at it as a sunrise and the beginning of an accident and injury free workplace. All injuries can be prevented. Thank you. (Applause)

Mr. Reynolds: I was impressed with all the presentations and I am also impressed with the continuity between the different railroads.

One of the things we would like to do now is open it up for you to see if you have any questions for any of the panelists. Does anybody have anything that would like to ask?

Member: Each presentation has shown a protection of human resources which is dear to all of our hearts, but it also showed a financial gain or windfall. My question to the panelists is, do their separate roads have some program in place to share these rewards with the management and labor which they attribute to the success of their programs through incentive programs and through increased resources for them to perform their job which would, of course, provide increased job opportunities? If there are no programs in place, should there not be programs in place to share this windfall with the people who really made it happen?

Mr. Reynolds: Would anyone like to address that?

Mr. Mitchell: From Norfolk Southern's standpoint, we have spent considerable money that has been made available in several ways. One is that we have equipped or are equipping our ballast cars to be automatic where there is no manual effort made anymore. People will be able to ride and you won't have the fatigue and these types of things. The gangs that we had here were able to be applied to provide a safer work environment. We have developed a hydraulic track jack in connection with Templeton Kenly that is out there and this is a much more expensive track jack than the manual type jack.

In answer to the question, we are putting resources into these other areas to help to ensure that we do have a safer environment and a safer workplace for employees.

Mr. Cashwell: If I understood Paul's question, it was based on the incentives that employees might receive for safety performance. We have several things in place on CSX. We have team awards that recognize team performance. We currently have 140 teams that are operating injury free beyond the year's period and once they attain 1,000 days, they get a monetary award for that, as well as at 1,500 days and at 2,000 days. We have spent close to \$100,000 this year on those types of rewards.

We also have a time-off program that again recognizes team and individual performance. For an employee who works injury free for a quarter, he gets a quarter of a day off. If his team is injury free, he receives another quarter of a day off. He can accumulate that and use that in conjunction with holidays and vacation time. We are about to implement a stock incentive program for 1995 that will reward all teams that perform better than a 1.5 frequency index level with shares of company stock. There are also local programs and division programs throughout our properties.

We do believe performance pays and we should share with our employees and we do try to do that in a lot of different ways.

Mr. Reynolds: Anyone else?

Member: I didn't hear a job safety analysis mentioned and I assume that several of the roads represented on the panel are using job safety analyses. I am curious as to who does and how do you disseminate them?

Mr. Mitchell: Do you mean doing an analysis of past injuries to change the job or being proactive?

Member: Being proactive. Involvement where you would analyze a work process and then dissect for that potential injury probability associated with the task and you actually write a short brief on how to perform the job safely.

Mr. Mitchell: It is an ongoing process. We have done it after injuries in the past and we are in the process of revising many of our rule books. That will be one of the things that we are going to do.

Member: Is this done with the first line supervisors? Is that how your company works?

Mr. Mitchell: We will do it with first line supervisors as well.

Mr. Reynolds: I think most everyone is doing that now. We have work environment teams, as we call them, where the people who do the work have a lot of time to analyze their job and their tasks, tools, and whatever, and make corrections and be proactive.

Member: Of the 309 supervisors who went injury free last year, what percentage of your supervision is that?

Mr. Mitchell: I am going to say that would represent 50 percent at least. I would like to readdress the first question, too, on the issue of safety incentives. We provide stock for employees who win in groups. We have a safety contest. For instance, our maintenance-of-way employees on one subdivision last year received over \$300,000, I believe, in stock. We have a number of divisions and groups that do receive shares of stock.

Member: Does Union Pacific use any outside consultants or safety programs?

Mr. Reynolds: We have used outside consultants in the past. I think that was in the 1980s. Dupont was the first consultant that we had and we have had others since then, but in the last few years we have not had any consultants on the property doing that type of work.

Mr. Mitchell: We have had Dupont on the property also, back in the late 1980s I believe. Dupont has a very good program as they do training in addition to having a very good safety record. They will give you guidelines and outlines and will basically hold a mirror up to you and show you where you need to improve.

Mr. Reynolds: I think we are about out of time. I would like to thank Jim Cashwell with CSX, Lane Ross with Burlington Northern, Mark Simmons with the Florida East Coast, and Max Mitchell with Norfolk Southern.

I have done these kinds of presentations before and I know the time and effort that goes into them and I know you want to thank them also. (Applause)

President Steele: Thank you, gentlemen. At this time we will break for lunch. Roadmasters will reconvene here in this room at 1:30. Bridge and Building will meet down the hall in the Cotillion Room at 1:30.

Monday Afternoon Session

PRESIDENT'S ADDRESS



Donald L. Steele

**Manager Bridge Construction
Union Pacific**

As of 11:00 o'clock this morning, registration is Roadmasters 224, B&B 81, suppliers 174, and spouses 82, for a total of 561. We are a little under this year, but this is still a nice turnout.

There is a video conference room down the hall that has some interactive videos. I can't tell you what they are, but there might be something that will strike your interest that you may want to watch. Feel free to go in there and browse around to see if there is anything you want to look at.

I wish to extend sincere thanks to each and every one of you for your attendance and interest and being part of what appears to be a very informative conference. As the conference program shows, we have a vast array of subjects and features that should be of interest to all. A lot of hard work was done to bring this conference to you. You, as well as I, have been graced by a board of directors that has devoted so much time and expertise in providing this conference to you. Without them, none of this would be possible.

Our board members each have a different idea on how our organization is run. What happens in the future will keep us strong. There are many opinions on this board and this is what makes the Association strong. It is always pointing to the future without falling into a rut.

There is proof that our Association is getting stronger and growing. We have gained 66 new members this past year. This, with the two words a few of us do not like to hear, downsizing and reengineering, clearly shows that there is an interest within the rail industry today for good down-to-earth information on what it takes to operate in our working environment.

There is also strong support from our office staff, Pat Weissmann and Barb Marlow. They ensure that all is in order for the Association and its membership. Besides our Association, they handle the Roadmasters and the Superintendents. This is a lot of work for two people. They ensure mailings go out to each of you, the newsletter and Proceedings get

published, and all other matters that affect the Association are taken care of. They also ensure all arrangements are made for each and every conference so we can, as attendees, sit back and enjoy without any hassle. With this great staff, our directors, and office help, I feel they deserve a round of applause. (Applause)

Five years ago, our Association embarked on a new venture in seminars. These seminars began with contracts and expanded to bridge inspection. They were put together to teach and inform members as well as any other interested party the various aspects of our work environment. The demand of these seminars is steadily growing. The last seminar on bridge inspection produced a profit of \$8,000. When we began, we only wanted to break even. The profits are going to allow us to create another much requested seminar on bridge repair. We are now in the process of putting together a seminar on bridge maintenance procedures. I cannot give you an accurate date, but we are hoping to have it ready late in 1995. We want to ensure that all aspects of bridge maintenance are covered and covered correctly so bear with us.

All this will happen under the guidance of Bill Nelson who is spearheading this effort with members of the Board. These seminars have been taught by our Board members and membership. A deep and sincere gratitude is owed to those who have given so much of their time to make these seminars the success that they are. It is now time to give these people a rest and I would like to invite any one of you to participate in this endeavor. We have a need for more people to assist whether by input or acting as an instructor. If you can help, let Bill Nelson, Pat, me, or any of the Board members know. I guarantee you won't be turned away. In fact, we did get one volunteer this morning, so it is working.

Recently I gave a presentation where I shared my feelings of the future. What I have is a vision, or maybe just a hope, of things to come. Presently we are like three lines that have come together to form a triangle. These three lines are REMSA, Roadmasters, and our Association. This triangle is a whole working unit pointing out the direction of progress for the rail industry. REMSA provides us with equipment and products to help do our work with more productivity and safety in mind. We, the B&B and Roadmasters, provide the people to utilize these products to our advantage and in a correct manner.

I stated earlier this triangle was a whole working unit. However, it is not complete yet. We need to work towards building a pyramid, the joining of four triangles. The other side to the pyramid not yet connected may be other associations of the rail industry, not only in North America, but all over the world. This, of course, is a dream. Or is it? Could it not be a goal to strive for?

This pyramid in a complete and pure form could only benefit the betterment of the world. Those who can not offer much now but can do so in the future will bring about a unification that will assist in every man, woman, and child having a better life.

As my term as President of this Association is coming to a close, I can say it has been a worthwhile experience. I began getting involved in 1984 when I gave a presentation on a special subject. I was just as nervous then as I am now. From there, I have been working through the Board to this most gratifying position I now hold. I have worked with people from many different railroads and companies and I have found there is a vast amount of knowledge and experience out there. I realize that getting involved requires time and effort, but it is a rewarding experience.

We have eight special subjects for next year, four of which will be selected and presented. There are yellow cards on the scopes in the back of the room. Take a minute to read through them, then complete the card and drop it in to the container at the back or give it to a director at the registration desk. We also ask that you complete the conference survey form you received this morning and give it to one of us at the conclusion of today's presentations. It is the knowledge and experience of each of you that makes this Association work and these special subjects worthwhile.

Once again, I thank you all for coming to this conference and for helping me to make my final year a satisfying experience. I plan to stay involved and help in any way I can for it is part of my dream that works for all.

At this time, I would like to turn this over to John Van Huis. (Applause)

Mr. Van Huis: Thank you, Don. Our first presentation this afternoon is underwater bridge inspection and sonar investigation. Our presenter is Gordon Barksdale, a division manager for America Inland Divers Incorporated, which is a wholly-owned subsidiary of a publicly-held corporation, American Oilfield Divers.

With the completion of a degree in marine technology, Gordon has had a career in the division industry that has spanned 20 years in both offshore and inshore industries. Gordon holds two patents on subsurface instrumentation.

For the last two years his primary responsibility has been underwater bridge inspection. Please join me in welcoming Gordon. (Applause)

UNDERWATER BRIDGE INSPECTION AND SONAR INVESTIGATION

Gordon Barksdale
American Inland Divers

Thank you very much. On behalf of my company, I would like to thank everyone for the opportunity to come and visit with you all.

What we are going to talk about this afternoon is underwater bridge inspections. Basically we are going to discuss the two means, which are manned diving operations and also technology through the form of sonar.

First, we will deal with manned diving operations. Basically when you conduct an underwater bridge inspection by use of putting a diver in the water, you have one of two options. The diver is either wearing scuba or he is using what we call hardhat gear or surface supply gear. As a rule, scuba is probably the older method of use for underwater inspections by divers. As the years have passed, most of the contractors have switched to the surface supply. Now, I would think sitting in this room this afternoon there are probably quite a few people who are actually scuba divers because it's a very popular sport. In fact, if you turn to the person next to you and look at him and he appears slightly unbalanced, there is probably a good chance he is a diver.

In the working world, we prefer the surface supply or hardhat diver. There are a number of reasons for this. First and foremost is safety. When you operate in this mode, the diver has a constant air supply. He is tended, meaning he has a physical connection to the surface for support in the event of problems. Secondly, and as importantly, basically diving is a means of transportation to get an individual or worker to a jobsite.

In the last seven or eight years, the quality of the men through training who are conducting these underwater inspections has improved tremendously. What I mean by that is diving is relatively easy. You can put on this equipment and quite safely go into the water, swim around, blow bubbles and talk. What is important is that the man who physically enters the water understands not only the safety considerations, but more importantly, the task at hand. As I said, in the last seven or eight years, there have been a number of programs offered and I

think if you do employ an underwater contractor to inspect one of your bridges, you will find that the diver has been specifically trained to inspect bridges both top side and underwater.

Again, the advantages are constant air supply and, what I failed to mention earlier, communication, meaning this diver is collecting information and relaying it top side.

Let's look briefly at what a diver does on a bridge inspection. As you see, we have our support vessel. Basically when you conduct a manned diving inspection, it's a tactile inspection. The waters in the United States as a rule have zero visibility. That means that the diver, the person conducting the inspection, is really doing it by feel. If you can, imagine this room was going to be inspected and you only had some drawings of it. They turned out the lights, and you had to enter the door and basically traverse the room and then report back what you found. It can be very difficult. Therein lies the training.

During the diving inspection, the diver works usually from a small surface supply vessel. He is physically going along the bents or the piers looking for physical deterioration, concrete spalling and scour. Of course, scour is probably the foremost of any bridge inspection.

The limitations of a manned diving operation for scour inspections are simply that scour is most likely to occur during periods of high water velocity and manned diving operations really cannot be used in velocities exceeding about five feet per second or three knots. The reason for that is you simply cannot withstand the water force. If you try to work in velocities greater than that, you are not going to get a whole lot accomplished.

When we get into the higher water velocities whether they are ambient water velocities, meaning the stream always flows that fast, or we get into a flood situation, then we turn to technology. One of the most common means and one of the most effective is an echo sounder, or fish finder as they are sometimes called, or even a pathometer. In these discussions, these fall under the term seismic devices and basically they are all acoustic which mean that they transmit a signal normally at around 200 kilohertz and they take the first return. So these echo sounder surveys are done a lot of times from very small crafts such as johnboats. They traverse both upstream and downstream of the bridge and of course what they are looking for is scour conditions.

To be done accurately they require the compliment of horizontal positioning. What that means is even the retail grade echo sounders are quite accurate. In fact, we often use them on projects. What I am talking about is a unit that you can purchase from the sports store for \$200 or so. They are quite accurate with the water depth data, but then you have to know where the data comes from. Therein lies the horizontal positioning which either falls under a total station, which is a very accurate laser based system; or GPS, which I am sure everyone has heard about, the global positioning system; or DGPS, differential global positioning system, which is becoming quite common and really the method of choice on a lot of river systems in the United States.

The advantage of these echo sounder surveys is that they are very economical. They are relatively easy to operate and they are very fast to mobilize. They can actually be conducted from the deck of the bridge if it's a fairly low bridge by putting it on a transducer pole, or in the case of DOT operations, from a snooper truck.

The disadvantage is if it is a high water condition you are again entering into the safety hazard of vessel operations in fast water.

One of the other options that exist in the acoustic or seismic instrumentation is a unit called a CBAT90001. It is relatively new instrumentation that came out of the U.K. Over the next few years you will probably be hearing a little more about it. The Corps of Engineers has put a lot of interest in this work particularly on the large waterways such as the Mississippi, the Missouri, and the Ohio. The difference between an echo sounder and a CBAT is that there are multibeam or multitransducers. An echo sounder has one transducer, sends one signal, and receives a return. This type of technology has 60 transducers, basically operates much like a strobe and so the amount of coverage or the amount of data density that you receive is quite high.

Again, it is vessel-operated technology and it does require the use of horizontal positioning so that you know where the Z data is taken from. It has the same disadvantages as the echo sounder, though. In the event of high water, you enter into a bit of a safety hazard.

Another technology that is gaining a lot of acceptance is the sonar scour vision system. Again, it's an acoustic technology. The big difference is that this technology was purposely designed to operate during periods of high water velocity. Over the years, we made a lot of attempts, both with manned diving and through some other basically subbottom profilers, to determine how much scour occurred during the flood period because we couldn't get our divers in and we couldn't get our boats in. The results were really quite disappointing. In certain soil conditions such as sugar sands and even some of the deposit clays, it is just about impossible to go and do a bridge inspection after the flood and accurately determine how far the scour hole went down.

There are, of course, a lot of computer models available today, specifically WISPRO and HECK II. We have done some comparison with those models against field data and it is promising although certainly the models if they are lacking one thing right now, it is around the abutments. They don't seem to have the right numbers there, but the sonar scour vision is a scanning sonar. It is deployed from the deck of a bridge, whether a railroad or a DOT bridge, and the depressor actually uses the water velocity to become a stable platform for the sonar. This sonar scans completely through both the vertical axis and horizontal axis and as the lines depict, is not only scanning the river bottom, but also the vertical structures, being the piers or bents.

This is what the data looks like. This is on the Brazos River. If you will look at zero on the Y axis and zero on the X axis, you will find a little red dot which was the position of the sonar during the time of survey.

This is a field data plot. This is actually what you see when you are out there in the field. On the right you have the elevations that in this case are referenced to mean sea level. Elevations, of course, can be referenced to any data available. The advantage is you get complete data density, as we call it, meaning you are covering every square inch. This is kind of a classic example of what we call contraction scour, meaning that the bent is not showing any evidence of local scour or undermining, but as you can see with the blue lines, the flow line has definitely started to channel out near the bent.

Last summer during the Midwest flood, a lot of both DOT and railroad bridges were inspected during that flood period on all of the rivers from the Des Moines to the Missouri and, of course, the Mississippi. It was really surprising. Since that was one of worst flood events that we have experienced in the country, a lot of bridges were closed, particularly traffic bridges, but they weren't closed to local scour, meaning the bents or piers were not undermined.

A lot of the Mississippi bridges were actually closed to what this slide displays which is contraction scour, meaning the flow line elevations had changed dramatically sometimes as much 50 or 60 feet from historical elevations.

By using this technology, you can get the planned view and, as I mentioned, it is also scanning in the vertical. You can actually see the pier wall or bent as the sonar is scanned down. As it is depicted there in the little square, that is the footing. The line is very jagged on top of the footing and what we are looking at when we look at this type of scan is just a very narrow crawl section or pencil beam so the footing will sometimes be very distinct. In this case, it had a little bit of riprap or debris on it.

The red profile traces down and that really is the issue right there. What is that elevation next to the footing referenced to what historically it has been, or what our previous inspection would show.

Again, the big advantage to this type of technology is this is what the engineer actually sees in the field at the time of survey, so if he has a scour problem or significant flow line change, he has immediate information at the time of the survey.

There are things that you do not want to see when you do a bridge inspection. You see the yellow and red colors there on the picture in a jagged line. Remember we are looking down on this. This is a planned view. The yellow and green is actually the pier itself with the water turbulence around it. The sonar is again at zero-zero on at the XY axis.

Again, on the left-hand side of the screen you will see the blue color go underneath the yellow and red or the jagged line. That is where this sonar was actually scanning underneath the footing. On this particular bridge, which was on the Iowa River, that particular piling supported footing was undermined over 12 feet.

One of the reasons that we started using this technology almost exclusively during the floods is two days prior to that a cursory inspection had been conducted on this bridge and on this very pier. It was using the echo sounder that I explained about earlier. The report came back that there was no sign of serious erosion or degradation. The engineer in charge of this bridge was still uneasy because of the velocity. He was shy at using this type of technology and found complete undermining. Comparing the data, it became obvious what the discrepancy was. They didn't realize how wide the footing was. The echo sounder was basically put on top of the footing so it never shot down basically to the river bottom.

That's a very good example of what a high density scanning sonar is capable of doing particularly during periods of high water and high velocity.

As I said, over the years we have used a number of different methods to conduct bridge inspection, and I would like to summarize for a moment. Manned diving operations, particularly years ago, didn't always produce the best results. I think if anything that was a fault of contractors in general, meaning that a diver is a diver is a diver is not true. A lot of the inspections were conducted by personnel who perhaps didn't have the training or, more importantly, just didn't have the experience around bridges. As I said, with the advent of training I think any contractor you call today who is in the bridge inspection business can put some very experienced people out to conduct the information whether it's a tactile inspection or even a post scour inspection.

The other is technology. These various sonars that I have described, the sonar scour vision, the CBAT and to a lesser extent even the echo sounders, are relatively new. By relatively new, I mean by less than two years. So for the engineer in charge of a bridge or in charge of conducting a periodic inspection, the tools that he has available to him today are far enhanced over what we had several years ago. Therefore, you don't have to rely entirely on field models or even gut instincts. Equipment exists. You can go out and get a very accurate inspection even during the most hazardous conditions.

When you are going to do a talk on bridge inspections the last slide has got to be either one of two things: a sunset or a damaged bridge. I picked a damaged bridge because I poked a hole in the slide that had a sunset on it. This is a bridge that the old Missouri River got. It was abutment scour that caused the majority of the damage and this is a situation I am sure a lot of you have seen before and certainly we have seen before. You get the flood and you can see where the water was up on the banks. The flood goes away and this is what we are left with.

Gentlemen, I appreciate your time. Thank you for the opportunity to visit with you.

President Steele: Thank you, Gordon. Our next presentation is by Leonard Lokey from Osmose.

Leonard began his career after graduation from the University of Georgia as a commissioned officer in the United States Navy. In 1968, he joined Osmose Wood Preserving Incorporated and is located in Griffin, Georgia. Sixteen years ago, he transferred to the railroad division as the area manager. Leonard is now the regional manager for the railroad division responsible for the contract services to regional and shortline railroads in the southeast. He is also national sales manager for the Osmose marine products group.

Through his years of working with hands-on inspections and crisis interventions for

marine structures, Leonard has become an expert at identifying and combating marine bore infestation.

This program promises to be informative and enlightening on the underwater inspection of timber piles. Please welcome Mr. Leonard Lokey. (Applause)

UNDERWATER INSPECTION OF TIMBER PILES

Leonard Lokey

**Regional Manager – Railroad Division
Osmose**

Good afternoon. I would like to thank you for this opportunity to present a program on underwater inspection of timber piles and the real story beneath the surface. Osmose railroad division personnel have enjoyed a good working relationship with many of the members of this audience.

For more than 20 years, I have witnessed astonishing changes in our marine environment. In the late 1960s, the United States Navy estimated the damage caused by marine borers to wharves, docks, and piers to exceed \$500 million each year in this country. Nearly 30 years later, one can imagine the current cost. Perhaps \$1 billion or more each year.

Out of sight, out of mind, is truly characteristic of man's thinking. Why should we be concerned with conditions that we cannot see or understand? Today we will focus in on the inspection of timber piles below the water surface and gain an appreciation of what is happening even as we speak.

A good case in point is the rather dramatic developments in the last three to five years in the United States coastal water environment, developments that are threatening the destruction of timber structures.

Historically, California has led the nation in reduction or elimination of industrial and agricultural pollution in our streams, waters, and sea ports. As a result, California has been dealing with a population explosion of marine borers for a number of years.

More recently, the Federal and State Environmental Protection Agency and the Corps of Engineers has restricted the movement of silt or soil from construction sites to the creeks, rivers, and harbors. The construction of the two-foot skirts or barriers on building sites are a major reason for this success. Harbor water conditions have improved dramatically along the Pacific, Gulf, and Atlantic coasts. These ideal conditions have created a new haven for fish in the harbors, oysters in the bay, and marine borers in timber structures.

The marine borers' history begins in salt or brackish water and tidal freshwater marshes and rivers. The marine borers have been here since the dinosaurs and are surviving as well as cockroaches.

The marine borers have played an important part in our history. Cleopatra's barge is said to have been sunk due to an attack of marine borers. Christopher Columbus suffered the loss of several ships from his fleet in the Caribbean due to marine borer attack.

There are two main categories of marine borers that cause most of the damage to timber structures. They are mollusk and crustacean.

Molluscan borers include the pholads or rock borers and teredo or bankia which are commonly called the shipworm.

Pholads look like small clams and they bore into soft rock and concrete as well as wood. Once they make their burrow, they remain in it for a lifetime. Pholads are usually more than a half inch wide. This is typical evidence of pholad damage to well treated timber. Remember that the pholad remains in this burrow for a lifetime.

The shipworm is often difficult to locate inside the pile and the damage is virtually impossible to quantify because they enter the wood no larger than a pin head and grow much, much larger inside the pile. The teredo is often 3/8 of an inch in diameter and grows to more than six inches in length. Bankia grow to 3/4 of an inch in diameter and often up to four feet long. This is the head of the shipworm.

This is an illustration of a comparison of teredo and limnoria infestations. Crustacean borers have three major groups of interest to us. The first is the limnoria or gribble which is the most damaging to our timber piles. Gribbles are no longer than 1/8 of an inch and may look like a grain of sand on your wetsuit when coming out of the water. A particular specie, limnoria tripunctata can even digest creosote. They can thrive well in creosote-treated timbers. The wood weakened through the infestation of gribbles has been diminished by the constant action of the ocean waves.

The chelura is about the same size as the limnoria; however, they most often live in and enlarge the tunnel carved by the limnoria. The chelura in this slide appear like they know where they are going. This is typical of the chelura damage.

Sphaeroma are becoming much more active in the Atlantic and Gulf Coasts from North Carolina to Texas. These borers are easily seen if present in the wood and are approximately 3/8 inches long. Please take note as sphaeroma can inhabit tidal freshwater areas with extremely low salinity.

We were recently surprised to find sphaeroma damage in the St. Johns River near Palatka, Florida, which is about 45 miles inland and south of Jacksonville. In our research, we found that sphaeroma destroyed a highway bridge at Palatka in the 1890s.

Sphaeroma are responsible for destroying 238 dual-treated piles in a marina near Sarasota in less than three and a half years.

Damage to timber by crustacean or the limnoria, chelura, and sphaeroma is more easily recognizable because the animals destroy the wood surface often leaving an hourglass shape. The attack is usually in the intertidal zone, but can be found the full length of the pile in unpolluted water.

Everyone in this audience has access to published data that can readily inform you as to whether or not marine borers are in the general area of your structures. This information will provide valuable clues as to how and where borer attacks may signal their presence. This chart entitled, "Marine Borer Hazards in the U.S. Coastal Waters," is very typical of the information that is available.

On this map you can easily see that on the West Coast from Washington to Southern California and on the East Coast from Maine to Key West and over to Texas, you have active areas for both limnoria and teredo. The hourglass shape is a typical trademark of infestation in these areas. Visual inspection will need to include inspection through the probing to discover the infestation of teredo, which are burrowed deep within the timber piles.

Sphaeroma and pholads are active from North Carolina to Key West and Texas only. They also leave the tell-tale hourglass shape on timber piles.

Scheduling the inspection at low tide is critical. One should be prepared to get wet and muddy if necessary. Several weeks ago, I was on an inspection trip via hi-rail. We were delayed two hours by unexpected train traffic. As you might know, we arrived at the bridge at near high tide.

Marine borer attack was evident in the bracing, but the severity of damage to piles was unknown. Knowing of the tremendous increase in marine borer activity throughout U.S. coastal waters, I decided to reinspect the structure when in the area a few weeks later. I

arrived at low tide as planned and was able to walk about 90 percent of the bridge. Borer attack was found to be severe and active. I was able to photograph the damage and provide this documentation to the railroad. As a result, the railroad will budget for replacement of cross bracing and wrapping of timber piles within the next six months in order to stop the borer attack.

Removal of barnacles and oysters at selected locations on piles and bracing is essential when inspecting. Borer attack is frequently hidden because of the abundance of marine growth.

It is important to check bracing timbers, particularly the end cut, which is normally below water at high tide. This is always an easy entry point for borers. Look for driftwood or old pile cutoffs under the bridge for evidences of borer attack.

Probing the pile with a sharp instrument and using an increment borer may be necessary to confirm the presence of the shipworm. It would be very important to plug all bored holes with treated wood plugs.

Once these inspection techniques have been utilized, it is important to establish a uniform method of reporting borer damage. The permon underwater inspection symbols is one of many systems available.

Just because a structure is 30, 40, or 50 years old, don't think the marine borer won't return to attack the timber. New York Harbor is currently experiencing a major borer attack after being dormant since the 1930s. In order to save these structures, thousands of piling must receive protection within the next few years.

Here are some examples of marine borer activity. At this particular port, a major underwater inspection revealed that immediate steps were needed to stop the marine borer attack. The authorities decided to delay any action due to a lack of funding. Eight months later, this dock collapsed. Soon after this disaster, measures were begun to repair all remaining structures.

This warehouse collapsed in on itself due to unprotected limnoria attack.

This gondola load of scrap metal failed to reach its original destination.

Now for the good news. There is still time remaining to save our timber structures experiencing marine borer attack. Research and development has been ongoing for many years. The Port of Los Angeles has completed numerous projects for evaluating various systems of repair and preventative maintenance procedures. Osmose has also had test plots for more than 40 years.

In one such system, new piling are wrapped prior to driving. Heat shrunk polyethylene material is applied to the pile on land. This does require the use of specialized equipment and careful handling of the pile at the project site. A propane heat source is used to shrink the material around the pile.

A system utilizing copper nickel sheathing to encapsulate a pile after receiving borer attack was evaluated. The materials and installation labor are too expensive.

A special coating of phenolic resin has been applied to pile surfaces prior to driving. This system is still being tested.

Hard forms made from fiberglass or metal pipe placed around the pile and then pumped with concrete have long been used for restoring structural strength.

Nylon bags with mesh wire and rebar have been pumped with concrete to restore structural damage caused by marine borers.

One of the most successful repair systems with many years of service life has been the polyvinyl chloride wrapping system. This method has been used extensively throughout the world with several million feet of wraps in place. This system is very economical.

In summary, research and development have created an abundance of benefits for all of us. We are enjoying cleaner air, better drinking water, and improved fishing in our rivers and harbors. The marine borer population is also enjoying the same benefits. Fortunately,

research and development has also provided us with effective solutions for controlling the lifestyle of the borer. The next time you see the ocean churning around your timber piles, remember the marine borer and where he wants to live. Is it in your timber structure or have you taken the necessary steps to stop them?

For those of you that might be interested, I have samples in the back of various pilings that have been attacked by marine borers. If any of you care to at the break, I will be back there and will be glad to talk to you. Thank you. (Applause)

President Steele: Thank you, Leonard. Our next presentation is Vincent Terrill of REMSA. Vinnie will bring us up to date on the innovations in the industry.

TECHNOLOGY UPDATE

Vincent Terrill

**Past President
REMSA**

I have a collection of slides that were given to me by some 20 different supply companies on what they thought of their materials and/or equipment in the way of new, innovative, and interesting developments, and I hope that you will find it that way as well. Generally they let me do this sort of thing because they like to get the suppliers out of the hallway. Since none of them trust me, I suspect they are all in here to listen to what I am going to say about their product. (Laughter)

HDR Engineering

HDR Engineering was responsible for the layout and design of an intermodal transfer facility on 130-acre site in San Bernardino. The ultimate goal of the facility is 500,000 lifts per year with 2,500 trailer parking spaces and a total capacity of 256 trailers or freight cars or 76 double-stack cars.

Layout includes mainline track relocation and curve reduction, yard track layout including a new seven-track support and switching yard, nine-lane entry gate and a five-track bridge.

Track layout involves changes in the yard leads and crossovers coming into the yard. Also included are the entry gate, office buildings, straddle crane maintenance, fueling facilities, paving and utilities, storm, water, sanitary, and electrical layout as well as strategy plans to maintain mainline traffic and existing intermodal facilities.

This slides shows Sheridan Avenue in Sheridan, Wyoming. HDR Engineering designed the upgrade of Sheridan Avenue including a new three-span concrete slab bridge over the Little Goose Creek, a new continuous three-span steel thru-girder bridge for the Burlington Northern railroad over Sheridan Avenue, a 2000-foot long railroad shoe fly to allow for uninterrupted rail traffic, a raise in the mainline track, 800 feet of reconstruction and widening of Sheridan Avenue with extensive storm drainage and utilities design and 400 feet of reconstruction of First Street and its at-grade crossing with a Burlington Northern Railroad track.

The Southwest Transit Ashland/Archer Station in Chicago, Illinois, is one of the largest public works projects to be undertaken in the 1990s by the City of Chicago. The Southwest Transit line extends the Chicago Transit Authority System with a link between downtown Chicago and Midway Airport.

HDR Engineering designed a half-mile section which is partially aerial structure and partially built on grade. The design also included the 10,000 square foot Ashland/Archer transit station. The north wall of the at-grade station serves as a retaining wall to the expanded railroad embankment. The elevated boarding platform spans the Chicago River, passes off the station, and extends over Ashland Avenue.

Burke Parsons Bowlby Corporation

Panel timber bridge decks provide worker safety, installation cost savings, and reduced track out of service time.

This is a panel ballast deck bridge, panels loaded on rail cars for shipment.

This slide shows bridge panels waiting for installation on the bridge.

This last slide shows the completed ballast bridge waiting on ballast to complete the project. Panel timber bridges can be fabricated to fit open and ballast deck installations.

American Inland Divers

American Island Divers, being a service organization, decided to list their services for all of us to see and read. The services include marine construction, bridge inspection, erosion, remediation, sonar scour vision, and underwater services.

The diving services include inspections, ratings repair, bridge rehabilitation, bridge analysis, and hydrodynamics vehicle contours existing subsurface conditions. Computer interface provides field plot on location.

David Clark Company, Inc.

Featuring noise attenuating head sets. High noise creates a safety hazard for railroad operation. It also interferes with communication between crew members. The David Clark Company noise attenuating headsets combine hearing protection with clear communication. Regardless of background noise, noise canceling microphones provide easy-to-understand transmissions.

The David Clark Company offers a variety of headset systems for use with mobile and portable radios. All offer improved communication and hearing protection.

Hougen Manufacturing Company

The Hougen Manufacturing Company presents the new Hougen portable magnetic drill. Introduced in November, 1993, Hougen now offers one of the lightest portable magnetic drills with the largest drilling capacity in its weight class. Weighing in at just 28 pounds, it has a drilling capacity of 1 3/8 inches at 2 inches DOC.

Hougen's line of portable magnetic drills are used in bridge construction, building erection, and general fabrication type work.

The roto-broach portable magnetic drill shown here is cutting holes in bridge support brackets for Manhattan bridge rehab project.

This slide is a portable electro hydraulic hole puncher. Producing clean and accurate holes in as little as 1 1/2 seconds has never been easier. There are six models to choose from. Each hole puncher is completely self-contained. There is no separate hydraulic hose to mess with. Units are lightweight starting at 13.7 pounds and delivering 7.7 tons of punching pressure. Punch from 5/32 inch to 15/16 diameters through sheet metal up to 1/2 inch thick material.

Hougen's 14,000 series hole cutter for handheld sheet metal applications.

The President of REMSA is Ken Norton as most of you know. Last night he gave us a talk on how most of the companies in REMSA are small and how they were very entrepreneurial. When I came in after lunch, I saw that Hougen has their entrepreneurial truck parked out there in front of the sidewalk. That's what I call entrepreneurial.

Portec Company

Portec GTP absorbent track mat was designed to answer the problems of soil and ballast contamination at locomotive refueling and ready station sites. The GTP absorbs leaks and

drips of diesel fuel, oil, and other hydrocarbons yet permits water to pass through. Its active material is a melt blown polypropylene that can absorb over 20 times its weight while retaining strength for removal and disposal. It is also effective for heat control underneath most types of rolling stock and truck maintenance equipment. GTP comes with a reusable plastic shipping wrapper for easy disposal.

Hatz Diesel of America

Hatz Diesel of America has met the growing demand for high speed, air-cooled diesels that run very quietly. Major railroads have begun using Hatz fully-encapsulated silent pack engines which meet or exceed OSHA sound standards on railroad-track maintenance machines. The silent pack multicylinder L series has a power range of 24 to 70 horsepower.

Also available is the Hatz Supra. The state-of-the-art single cylinder diesel engine is available in silent packed version. The sound level from the very quiet running Hatz engines is lowered another 10 to 12 d/b/a's. The Supras have a power range from 3 to 15 horsepower.

Syntech Inc.

Syntech Inc. Syntech's track-collector pan systems are used for splash and spill containment for industrial and railroad facilities handling oil, fuel, and chemicals. Track collector pan systems offer protection whether rail cars and locomotive are loaded, unloaded, washed, or fueled. The pans are used to prevent dangerous chemicals or materials from contaminating the ground soil and protecting cross ties, ballast, or rail from materials that corrode the rail or deteriorate the ties.

Syntech's railroad car covers are one or two-piece covers for grain cars, high or low gondola cars, and steel coil cars. They are used to protect the cargo and to decrease the wind drag on the train itself.

Osmose Wood Preserving Inc.

Osmose is a wood preserving company whose railroad division provides contract inspection and repair work for timber bridges and steel bridges. From inspection to repair, they cover all the angles. Concrete bridges from inspection to whatever it takes, shotcrete epoxy injection, or cast-in-place restoration. They also manufacture and apply nonflam, the fire retardant coating to protect timber-deck bridges.

Reach All Company

This truck is equipped with a Reach All model UB30 bridge inspection and maintenance unit. It has the capability of getting on track at remote crossings. The UB30 operating without the use of outriggers and stabilizers can move forward or backward on the bridge while fully deployed. A variety of U.S. built trucks can be furnished. The UB30 can reach 30 feet horizontally under these bridges, enough reach for double track bridges.

At the end of the telescope section, a platform is attached to the end of a hydraulically-articulated fourth boom. This will put the workers behind deep girders. The platform is equipped with 110 volt air and hydraulic power which is provided for tools, heaters, and flood lights. It is kept level automatically by a hydraulic leveling system.

In addition to operating off either side of the truck, the UB30 is equipped with a second rotating turntable which enables the workers to thread through trusses. Once through, the platform can be rotated under the bridge. The UB30 also has overhead capabilities. The workers can be placed 29 feet above the track so that overhead inspection can be performed.

Templeton Kenly Simplex

The Simplex bridge and trestle jack model TJ109B incorporates all the features of a standard power claw track jack with the added feature of a narrow four-inch wide base. The TJ109B easily fits between double set ties and the short level bar, 36 inches, and low handle effort, 9 pounds at 10 tons, greatly reduces the risk associated with jacking from bridges and trestles.

The Simplex jack can lift from the toe or the cab making it ideal for spreading or jacking from piling or piers beneath the deck. The jack can also be converted to or supplied as a remote version for multiple point lifting from a single remote power source.

STS Systems Inc.

STS Systems Inc., are snap tight specialists. This is a picture of an existing culvert with joint separations joint offsets, and the bottom corroded. The snap tight liner system is a smooth, lightweight chemical and abrasion resistant pipe that renews existing culverts. No digging required. Your own maintenance crews can install the liner using conventional equipment. Only simple tools such as come-a-longs are required. The liner can be pushed or pulled into place. It can be installed in limited rights-of-way in lengths of 2 feet to 40 feet. The liner is sealed and grouted into place. This is a 48-inch OD liner inside a 60-inch RCP culvert. The industrial grade pipe will give you an indefinite service life well in excess of 50 years.

Surety Manufacturing and Testing Ltd.

Surety Manufacturing produces the anray horizontal lifeline system that will provide 100-percent fall protection during bridge deck replacement. During installation of horizontal lifeline brackets, Surety's rail slider anchorage connector and shock absorbing lanyard will satisfy the requirement for a temporary fall arrest system when working on field side of the rail.

The lightweight rail slider can be quickly installed or removed from most rail without special tools and with minimum instruction.

Rail Quip Inc.

Type GS80 has a boom radius up to 70 feet and a capacity of 100 ton plus. This crane is diesel hydraulic. The crane travels in transformation at a maximum speed of 75 miles per hour and once there has a very short rigging time for quick operation. The telescopic boom can lift and can travel heavy loads in a horizontal position at a low clearance.

The self-propelled speed is 25 miles per hour. It is continuously adjustable with no shifting. The larger cranes may be equipped with a leveling device to allow full lift capacity on super-elevated curves.

Manisman Demarg Gotweld

The Manisman Demarg Gotweld crane type GS40 lays steel girders. Boom telescopes horizontally with full load. With its counterweight extended, the crane can lift and travel with maximum load without the admissible wheel load being exceeded.

USSC Company

USSC manufactures an ergonomically-designed seat which incorporates the need of maintenance-of-way equipment. The 81-16 offers 9 1/2 inches of fore/aft adjustment along with a mechanical suspension system which is most advantageous in railway equipment application. It is made with high density-polyurethane foam and covered with industrial grade vinyl to prolong life in sheltered or unsheltered equipment.

Truck Bridge Bodies by Omaha

Omaha's standard line bodies are designed with the utility and telephone industries in mind. The Omaha standard line bodies can be engineered to fit any application. The all-galvanized steel body and structural steel understructure make the line bodies among the toughest in the industry. Omaha Standard stands behind the line bodies with a five-year limited warranty against rust through, hinge or door lock failure.

Omaha Standard Patriot truck bodies. The Patriot is engineered for demanding industrial and general hauling duties. The high-performance, low maintenance Patriot is designed to deliver long years of trouble-free service. The Patriot is available in 9 feet 6 inch, 12 feet, 6 inch, and 14-foot models.

Omaha standard heavy-duty drop-side contractor bodies. Durable heavy-duty drop side contractor is ideal for commercial operations such as road and building construction, highway maintenance, and landscaping. The drop-away sides facilitate the loading and unloading of cargo. The heavy-duty drop side contractor bodies have the heaviest understructure on the market. The double wall, double-acting tailgate is equipped with forward controls and can be used for dumping or spreading operations.

Georgetown Rail Equipment Company

Georgetown Rail Equipment Company owns and operates unique and efficient-aggregate delivery systems known as dump trains. The dump train unloads and places aggregates at rate up to 2000 tons per hour. The fully pivoting transfer boom allows precise placement of materials up to 53 feet from track center line even in front of itself.

Since 1986, six Class I railroads have utilized the dump train's efficiencies in bridge filling, shoulder enhancement, walkway material placement, sub-ballast, wind rowing, surface ballasting, and washout repair. The dump-train, aggregate-delivery system offers speed, versatility, and safety.

TC Johnson Company

The next two slides are of the manufacturing 20-ton on/off track hi-rail crane product which they are supplying to the North American rail market. The slide shows the model RTR58 which is a 20-ton capacity machine with a fully hydraulic boom which has a maximum reach of 60 feet.

Features of these machines include fully computerized load-moment indicator systems for providing complete load monitoring, load radius, boom angle on outriggers, rubber, and hi-rail. The cranes are set up with a specially designed partial outrigger spread which allows the crane operator to set the outriggers at an 11 foot width on bridge decks and provide a completely computerized lift chart in this operating configuration.

The units provide the capability of handling heavy concrete bridge gaps and other bridge repair material.

Camcar Textron

This slide shows the new 7/8 inch, cam-rail, screw-spike, alloy-steel, heat treated to 150,000 psi and coated with cam coat. The 7/8 inch high-strength screw spikes are used for high tonnage rail and bridge-traffic tie and timber plates, base plates, and all severe curve rail applications.

The Power Team Company

The Power Team pumps, rams, and controls are available for an endless variety of bridge lift application. Here, 32 pump and 100-ton ram sets were operated simultaneously to lift an overpass.

That, ladies and gentlemen, is the REMSA presentation. I am sure if you have questions, there are various suppliers that I am sure are willing to take any questions about any of their products that you saw here. Thank you.

President Steele: Our next presentation is a special subject entitled Bridge Bearings. The sponsor is Dale Bartholomew. Dale will introduce the chairman. (Applause)

Mr. Bartholomew: Rick Calhoun is chairman of the special subject on the replacement of bridge bearings and retrofitting of bridge bearings. He has been employed by Hazelet and Erdal for the past eight years, where he is a senior project manager and vice-president. Prior to that, he was a design engineer employed by the American Bridge Division of U.S. Steel.

He is a graduate of Michigan State University and is a member of the American Railway Bridge and Building Association and AREA Committee 15, which is the steel bridge committee. He has been active on the task force for the rewrite of the new chapter 19 on bridge bearings.

Rick is also a member of the American Institute of Steel Construction, American Society of Civil Engineers, the American Concrete Institute, and the Structural Engineers Association of Illinois. He is presently a registered professional engineer in nine states.

He has performed bridge inspections, rating analysis, and design of many bridges both fixed and movable for many of the railroads represented here today. He is presently the project manager of the new 170-foot long rolling lift bascule bridge which is being constructed for CSX Transportation in Pascagoula, Mississippi.

SPECIAL SUBJECT BRIDGE BEARINGS

RETROFITTING OLD ROCKER AND SLIDING ROLLER BEARINGS WITH ELASTOMERIC AND OTHER NEW SYSTEMS

Chairman: R.L. Calhoun, Hazelet + Erdal, Inc.

Vice-Chairman: D.F. Sorgenfrei, Modjeski & Masters

Committee: C.L. Rood, SEPTA

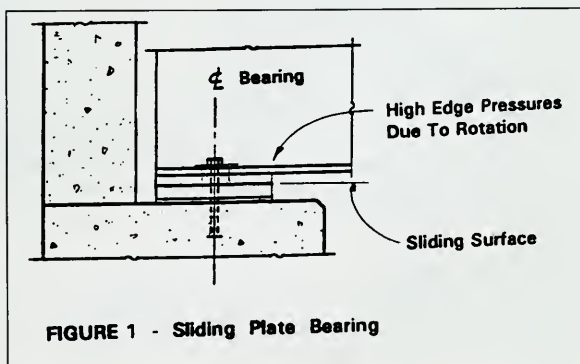
W. Rymasz, Barrett & Associates

A.S. Uppal, Canadian National Railways

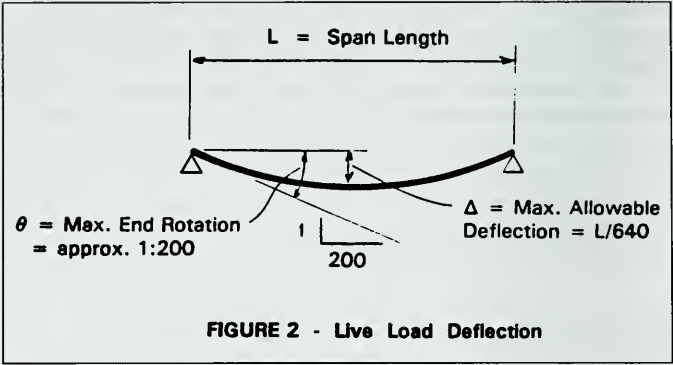
A major problem confronting many railroad bridge departments today is the deteriorated and improper functioning of many of their bridge support bearings. The older steel roller or rocker bearings may be worn, "frozen" due to corrosion or in misalignment causing unintended fixity, or non-functioning due to inadequate uniform bearing pressure or substructure movement. These problems may eventually cause further damage to the substructure or superstructure spans if they are not rehabilitated or replaced with a properly designed bearing.

Bridge support bearings are provided in many configurations and sizes and are intended to be either fixed or expansion. Both types of bearings must safely transmit all the vertical and horizontal forces on the superstructure into the substructure or support bents. The vertical forces include the dead load of the span and track, the live load and impact from the moving equipment, and snow or ice loading. The horizontal forces on both types of bearings include: wind, stream flow, centrifugal and seismic forces, and horizontal forces from the moving equipment.

The fixed bearing must transfer the longitudinal forces, such as traction and braking of the train, into the substructures, while the expansion



sion bearings must enable the span to move longitudinally to accommodate changes in the length of the span due to end rotation and changes in temperature. The fixed and expansion bearings must also allow for rotation caused by deflection of the span.



Existing Bridge Bearing Types

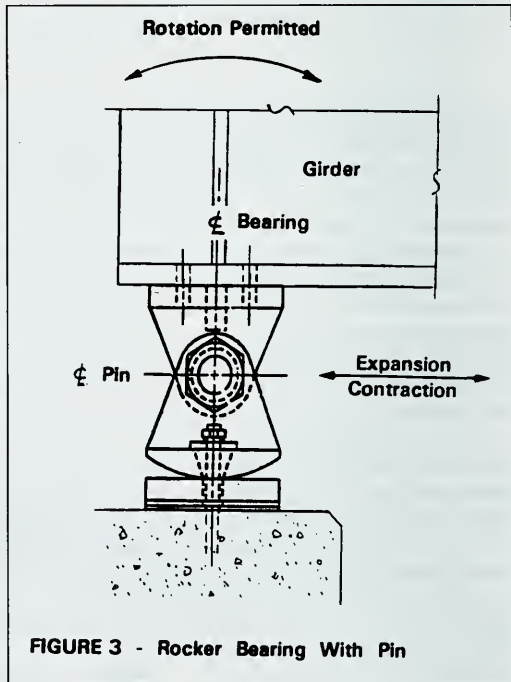
Sliding Steel Plate Bearings

These bearings, illustrated in Figure 1, consisting of two flat plates in sliding contact with each other, are normally used on shorter steel spans (up to 70 feet in length) where thermal expansion is relatively small. The upper plate is attached to the superstructure and the lower plate attached to the substructure. The anchor bolt holes in the span are normally slotted to accommodate the expansion and contraction of the superstructure while the anchor bolts resist the transverse loads. The sliding surfaces are subject to high bearing pressures on the edge closest to the span due to lack of rotational capabilities. The edges are then susceptible to dirt and moisture causing rust pack and corrosion which will increase the coefficient of friction between the plates and may eventually cause the bearing to freeze. If the slotted anchor bolt holes become filled with dirt or ballast, the anchor bolts may deform or shear from the thermal forces which are attempting to expand or contract the span. Using an oversized washer to cover the slotted holes may prevent dirt and ballast accumulation.

As illustrated in Figure 2, the recommended maximum deflection for live load plus impact on simple spans is $L/640$ (AREA Chapter 15, Section 1.2.5b). Assuming a uniformly distributed load on the span, the maximum end rotation for any span length is $0.17'$ ($1:200$). When rotation is prevented within the bearing, unintended fixity may cause damage to the superstructure.

Rocker Bearings

These bearings, illustrated in Figure 3, consist of a masonry plate



and a curved rocker or a rocker and hinge assembly. The rocker type bearings are normally used for medium length spans (up to 200 feet) where end rotation and thermal expansion allowances are necessary. Pintles or shear keys are normally used to resist the transverse forces. Dirt and moisture may collect under the rocker causing corrosion and impeding the ability of the bearing to rock longitudinally. Or the rocker pin between the upper connection and the lower rocker may freeze from corrosion.

Roller Nest Bearings

These bearings, illustrated in Figure 4, are similar to the rocker type, except there are multiple rollers either cylindrical or segmental. Roller nests are normally used for longer spans (over 200 feet) requiring a much greater bearing area, where a single rocker cannot be provided of sufficient diameter and length necessary to accommodate the support reaction. Alignment of the multiple rollers is essential and is usually accomplished with end retainers and tie rods. Individual rollers in the roller nest are very susceptible to seizing due to dirt and moisture that accumulate between the rollers. This may create flat spots on the roller or depressed areas on the bearing plate. The tie rods attaching the individual rollers may shear, causing the roller to skew and act as a sliding bearing. This is the most difficult type bearing to maintain.

As part of routine bridge inspections, the position of the rocker and roller nest bearings and the ambient temperature should be recorded, similar to the example shown in Figure 6. Over a period of time, this will enable a determination to be made whether or not the expansion bearings are functioning correctly. The plumb of the support foundations should be mon-

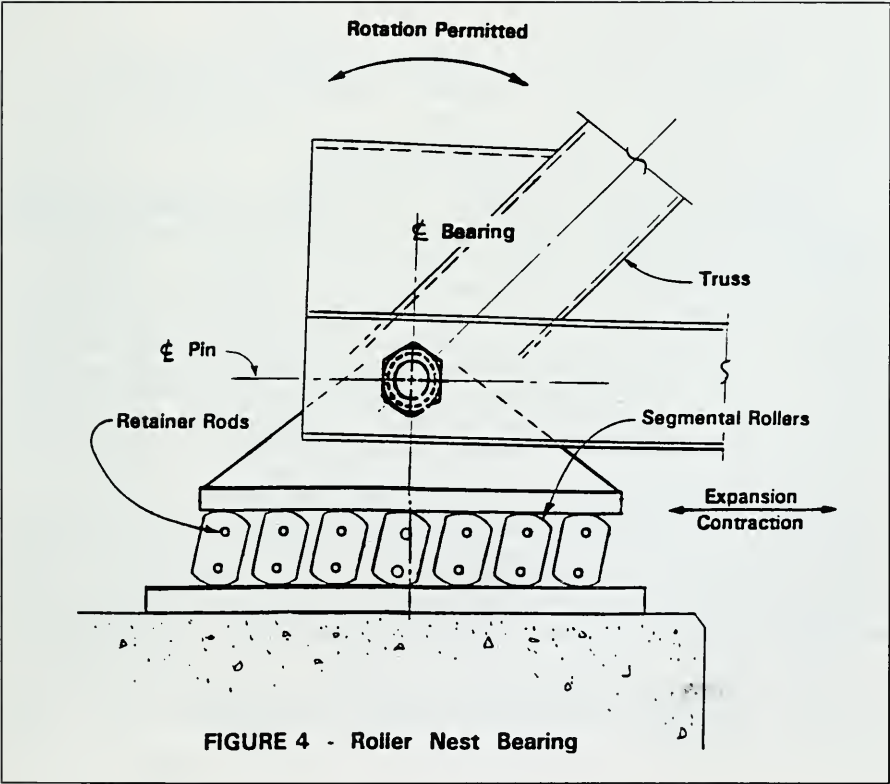


FIGURE 4 - Roller Nest Bearing

itored concurrently with the bearings to determine whether or not they are accommodating the movement of a problem bearing or contributing to the problem.

Fixed Bearings

The supports at one end of each span must be fixed, as shown in Figure 5. In addition to vertical and transverse loads, the fixed bearings must also transfer the longitudinal forces into the substructures. For spans over 70 feet in length, these bearings must be able to accommodate end rotation due to deflection.

Problems with fixed bearings are usually caused by differential settlement or movement of the substructure or wear and corrosion on the pin or mechanism which allows rotation. A corroded or frozen pin will prevent uniform distribution of live load stresses. Pins in fixed bearings, as well as pinned joints, can often be ultrasonically tested to detect wear. Occasionally bolsters beneath these bearings have inadequate stiffeners, resulting in bent stiffeners or cracked bolsters.

Frozen expansion bearings will increase shear stresses in the fixed bearing anchor bolts. This may result in deformed or sheared anchor bolts or cracks in the concrete bridge seat at the expansion or fixed bearings. Cracks or spalls in the bridge seat around the anchor bolts is often the first area to be affected by frozen bearings.

An increasingly significant factor in all bridge and bearing rehabilitation is seismic consideration. The relatively recent earthquakes and subsequent devastation in California have increased the engineer's awareness of the potential for bridge damage. When retrofitting a bridge for new bearings, certain seismic factors may need to be considered. These include: the type of soil, the type of foundation (typically taller and more highly stressed foundations achieve the largest natural period) and, the type of new bearing (an elastomeric bearing capable of multi-directional displacement may be best and a vertical lead plug is often used to help dissipate energy).

Most existing bridge support bearings are either fabricated structural steel or cast steel. In all likelihood, these bearings have served adequately for many, many years. However, the original designer may not have anticipated the conditions to which the structure and bearings would be subjected during the structure's lifetime. After all the information regarding a problem bearing has been obtained and reviewed, it may be necessary to rehabilitate or replace the older bearings. The most obvious option to the bridge engineer is to correct the defect (i.e. repositioning, cleaning or lubricating the bearing) or replacement of the bearing "in-kind." If the decision is made to retrofit the existing bearing using a modified type of bearing, the cause of the existing bearing problem must be determined and not simply provide a remedy for the obvious symptoms.

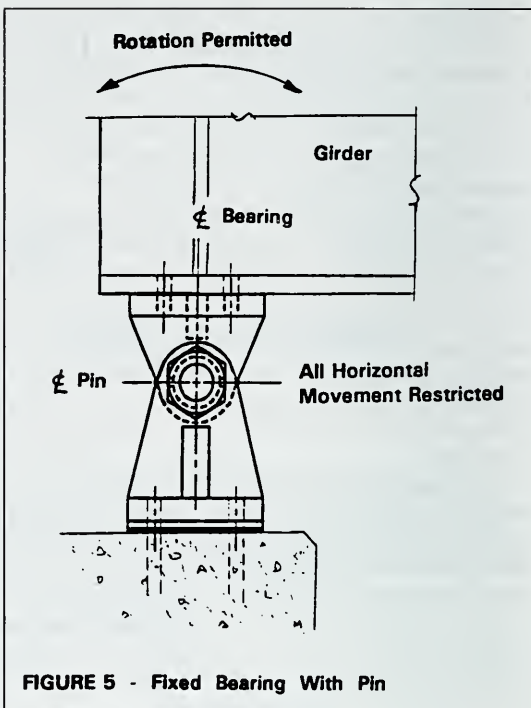


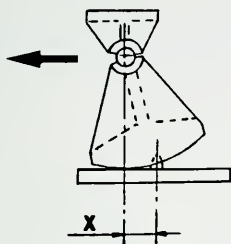
FIGURE 5 - Fixed Bearing With Pin

Railroad: Galaxy Shortline Express

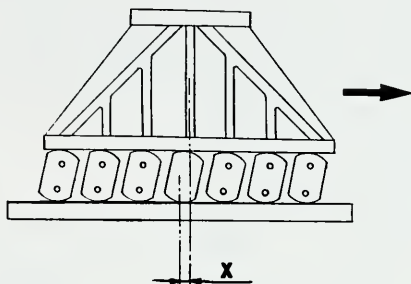
Bridge No.: 3872.4

Line Segment: LS-V1513a

Location: Hometown, USA



TYPE A



TYPE B

Note: Direction of displacement (East or West) is the top of the bearing relative to the bottom of the bearing.

Pier	Bearing Type	Displacements, inches				Date	Weather	
		North Girder or Truss		South Girder or Truss				
W. Abut.	A	1.250	West	1.625	West	11/04/87	40° F	Overcast
3W	A	0.312	West	0.000	----	11/04/87	40° F	Overcast
3E	A	0.250	East	0.125	East	11/04/87	42° F	Overcast
5W	A	0.375	East	0.188	East	11/04/87	42° F	Lt. Rain
5E	A	0.500	West	0.375	West	11/05/87	43° F	Clear
6E	B	0.250	West	0.375	West	11/05/87	46° F	Clear
8W	A	0.188	East	0.000	----	11/05/87	47° F	Clear
8E	A	0.250	West	0.188	East	11/05/87	47° F	Clear
9W	A	0.000	----	0.062	East	11/05/87	45° F	Overcast
9E	A	0.625	East	0.250	East	11/05/87	45° F	Overcast
E. Abut.	A	0.250	East	0.000	----	11/05/87	43° F	Lt. Rain

FIGURE 6 - Bearing Displacement Table

Retrofit Bridge Bearing Types

Today's bridge engineering departments have several more options available to them than did their predecessors just 30 years ago. Several types of bearings have been developed with the intent of reduced maintenance and more reliable performance.

Elastomeric Bearings

These bearings, with no moving parts to corrode, were developed to provide a maintenance-free device capable of multi-directional displacements and rotations, characteristic of elastomeric material. Figures 7a and 7b show typical expansion and fixed elastomeric bearings, respectively. They can be molded using either neoprene (synthetic rubber) or natural rubber with a hardness of 50 to 70 durometer, which is relative to the material stiffness. The elastomer is normally vulcanized or bonded to top and bottom load plates. The top and bottom load plates are recommended to avoid "roll-over" tensile stresses during horizontal displacements. The bearings can be molded in a plain pad, with internal steel reinforcing plates, or fabric (usually fiberglass) reinforcing. Figures 8a and 8b illustrate the purpose of the internal reinforcing, used to reduce the side bulging strain.

As shown in Figure 9, the elastomer can also be confined with a steel cylinder to minimize the side strain. These are commonly referred to as "pot" bearings. When contained in such a manner, the elastomeric cannot bulge outward and the bearing can withstand much higher compressive loads. The upper element acts as a piston, with seal rings to prevent the leakage of the elastomeric material. However, caution must be taken when designing pot bearings due to the high possibility of eventual wear on the seal rings allowing extrusion of the elastomer under the high loading pressures and subsequent reduction in the rotational clearances.

The advantages of the elastomeric bearing is its multi-directional displacement and rotation

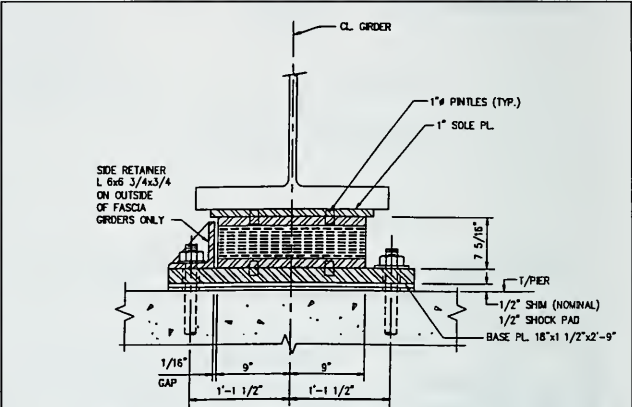


FIGURE 7a - Elastomeric Expansion Bearing
For a Non-Seismic Area. Rotation in Any Direction,
Expansion/Contraction Parallel with Girder,
Transverse Horizontal Movement Restricted

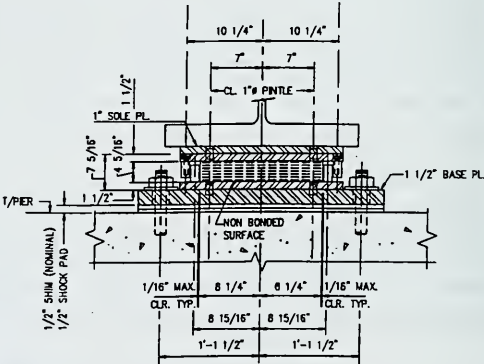


FIGURE 7b - Elastomeric Fixed Bearing
Rotation in Any Direction,
All Horizontal Movement Restricted

capabilities, making it particularly well suited for skewed spans. Because the elastomer must accommodate the horizontal displacement and the rotation, the bearing must be accurately installed relative to temperature. However, the precise alignment with respect to the centerline of the girder or truss is less critical than with rocker or roller bearings. Because it will not corrode or freeze, it is the most maintenance-free bearing available. The bearing does have limitations. It often requires a larger area on the substructure due to allowable bearing pressures of 800 psi for unreinforced elastomeric bearings and 1,000 psi for reinforced elastomeric bearings (per AREA Chapter 8, Section 18.3.4). This is compared to the older

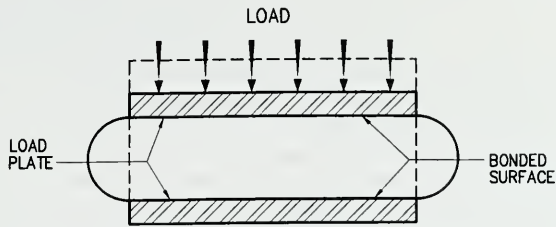


FIGURE 8a - Single Layer Elastomeric Bearing

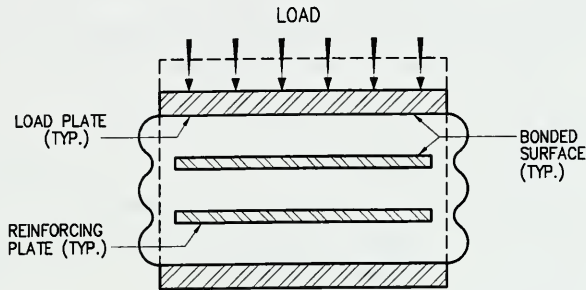


FIGURE 8b - Multi-Layer Reinforced Elastomeric Bearing

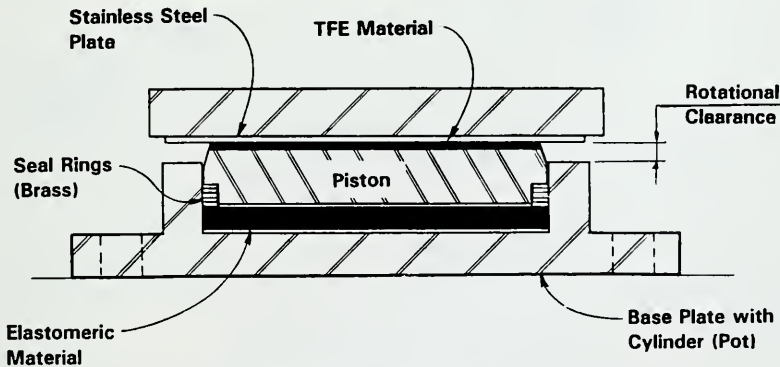


FIGURE 9 - "Pot" Bearing
Rotation in Any Direction,
Horizontal Movement May Be Restricted

cast or fabricated steel bearings with allowable bearing pressures of 20,000 to 27,000 psi.

The fluid nature of the elastomeric is unlike many other engineering materials and there are limitations on the height versus horizontal displacement and the width/length ratio (shape factor). For these reasons, an elastomeric bearing may not be suited for all retrofit projects. The anticipated life expectancy for elastomeric bearings is 40 to 80 years.

Although AREA allows the use of neoprene or natural rubber, it should be considered that neoprene is less susceptible to damage from heat, certain oils and chemicals, such as creosote. Neoprene is also less expensive than natural rubber. Because the properties of the elastomeric change with temperature, it is very important that the correct material be selected for each application. Only natural rubber is recommended for locations where the temperature may be less than -25 degrees Fahrenheit for several days. The accepted temperature ranges for elastomeric bearings are -30 degrees Fahrenheit to +200 degrees Fahrenheit for natural rubber and -10 degrees Fahrenheit to +200 degrees Fahrenheit for neoprene.

Because the majority of the bearing is composed of elastomer, the bearing will compress under live load. It has been recommended, for proper ride comfort on passenger cars, that a total vertical movement (from the top of rail to the substructure) under live load be limited to 1/8 inch.

TFE (Tetra-Fluoro-Ethylene) Bearings, commonly referred to as Teflon

The TFE material can be provided in either a woven fabric or in a solid sheet for use in bearing devices. The woven fabric has a lower coefficient of friction than the solid sheet material; however, the woven fabric is more expensive. These bearings with their low coefficient of friction provide excellent sliding surfaces. When used with a highly polished stainless steel plate, eliminating the need for lubricants which can collect dirt, they also reduce the potential for corrosion. The stainless steel plate should be placed above the TFE material and be of a sufficient size to always cover the TFE surface during expansion and contraction of the span. Since it is crucial to reduce the friction on a sliding bearing, TFE has been used to replace the older steel-on-steel sliding plate bearings in lieu of adding a means to grease or oil the older bearing.

However, the allowable bearing pressure on the TFE surface is typically 2,000 to 3,000 psi, which is considerably lower than the steel plate bearings. The TFE bearing also has limitations; a separate means is required to provide the necessary rotation at the bearing; the contact surfaces must be protected during construction to prevent contamination; and the teflon surface will wear and eventually require replacement. The anticipated life expectancy of a TFE surface is 40 to 80 years.

Self-Lubricating Bronze Bearings, with Graphite or TFE Inserts

Similar to the TFE Bearings, the self-lubricating bronze bearings will only provide a sliding surface and a separate means must be provided to accommodate the necessary rotation. In some cases, this has been provided by using a flat bronze plate for the expansion/contraction and another bronze surface, either machined spherically or as a rocker, to allow for the rotation. On radially or spherically finished bronze bearings, the concave portion should always be above the convex portion. This reduces the likelihood of trapped water and dirt which will damage the bearing. The concave surface is also finished to a slightly larger radius than the concave surface. The bronze surface has an allowable bearing pressure on the net area of 2,000 psi (per AREA Chapter 15, Section 1.4.1) which is slightly higher than the elastomeric and comparable to the TFE bearings. The lubrication inserts which protrude 1/32 of an inch above the bronze surface should comprise approximately 25 to 30 percent of the bearing area.

A consideration which must be made when using this type of bearing is the amount of movement to which it will be subjected. Failures of this type of bearing have resulted from small movements which do not allow the self-lubrication to be utilized by the entire bearing

surface. This may cause the bronze surface to wear more rapidly than the TFE under the same conditions, and eventually require replacement.

Combination Bearings Using More Than One of the Above Types

Numerous combinations and configurations of the above materials are possible. The TFE sliding surface can also be used in combination with a curved machine-finished self-lubricating bronze surface as shown in Figure 10. The TFE accommodates the expansion and contraction of the span while the curved bronze surface allows for the rotation. Multi-directional rotation can be provided by a spherically finished bronze surface. Directional retainers are often used to limit movement to the desired direction.

Similarly, where individual bearing loads are less, elastomeric and TFE combination bearings have commonly been used for highway structures. The elastomer provides for the rotation and the TFE provides for the horizontal displacement. The TFE can be vulcanized to a load plate at the same time that the elastomer is molded. However, unless there is a height restriction, it may be advantageous to design the new bearing to allow the elastomer to take the horizontal displacement and eliminate the combination of TFE and elastomeric materials.

There are certain limitations to all three proposed retrofit bearing types. The proposed retrofit bearings are more susceptible to damage from fires than the old cast or fabricated steel bearings. Careful quality control must be performed during design, manufacture, testing,

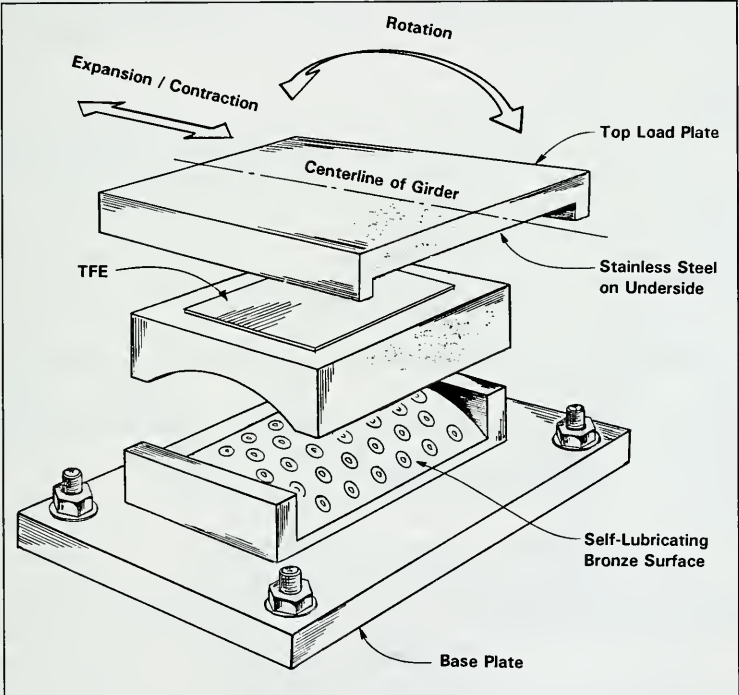


FIGURE 10 - Combination Bearing
Guided expansion bearing allowing rotation between the lower self-lubricating bronze surface and the center steel element and longitudinal movement between the top plate and the center element with a TFE attachment. Transverse movement is restricted.

and installation. Without sufficient quality control in the design, manufacture, testing, and installation, problems can result. These include: rupture of the elastomeric due to bond failure at the reinforcing plates, tearing or roll-over of the teflon sheet, or gouging of the bronze plate. The allowable bearing pressure is also less than that of the steel bearings, thereby requiring a larger area to properly support the new bearings. All three types of retrofit bearings do require a minimum load. No uplift forces should be allowed. Although the new bearings will require much less maintenance, they are not totally maintenance free. They should be inspected annually for evidence of damage, excessive wear, and misalignment. The exposed elastomeric bearings should be examined for evidence of cracks or splits in the elastomer. The exposed elastomeric bearings are also more susceptible to vandalism.

Prior to deciding to replace the support bearings on a span, an investigation should be made of the substructure and superstructure. Has the malfunctioning bearings or lack of uniform bearing pressure caused damage to the substructure? Has the substructure shifted or settled contributing to the bearing problem? What are the seismic requirements and how will the new bearings accommodate any seismic requirements? Is the span skewed or does it have curved girders which are not compatible with the orientation of the present bearings? Are there provisions on the substructure for jacking the span to replace the bearings? Are there height limitations for the new bearings? What is the size of the substructure bridge seat which must accommodate the new bearing? Can the change-out be done under traffic?

Presented in Figure 11 is a comparison of the different bearing types. The actual values may vary widely depending on the design, manufacture, installation and maintenance of each bearing.

Conclusions

Much depends on the proper functioning of the bridge support bearings, yet they are expected to perform for many years with little or no maintenance. Without proper bearing maintenance, the substructures, the superstructure, and/or the bearings will require rehabilitation or replacement sooner than anticipated. Prior to rehabilitation or replacement, it is important to identify the source of the problem and design the bearing to reduce the likelihood of reoccurrences. Although the final decision to replace or retrofit the bearings when eventually required will be economics, there is no substitute for a properly designed bearing and as illustrated here, the engineers today have more options available to them.

Bearing Type	Allowable Bearing Pressure, psi	Coefficient of Friction	Temperature Range, °F	Anticipated Life, years	Lifetime Maint. Costs
Fabricated or Cast Steel	20,000 to 27,000	0.80 Steel on Steel	-50 to +250	150	High
Elastomeric	800 (Unreinforced) 1,000 (Reinforced)	Check Shear Resistance	-30 to +200 (Natural Rubber) -10 to +200 (Neoprene)	40 to 80	Low
TFE	2,000 to 3,000	0.03 (Woven Fabric) 0.08 (Solid Sheet)	-30 to +400 (Woven Fabric) -30 to +150 (Solid Sheet)	40 to 80	Moderate
Self-Lubricating Bronze	2,000	0.10	Depends on Insert Material	40 to 80	Moderate

FIGURE 11 - Comparison of Bearing Types

Thank you. (Applause)

Mr. Van Huis: Yesterday at the Board meeting we decided to take a step to ensure the future of a few future engineers and attendees to our conference. As you know, the last few years we have been running some very successful seminars such as bridge inspection and contract services. We are working very diligently on bridge repair because everyone seems to want to follow up bridge inspection. Since we told you what is wrong with the bridge, you now want to know how to fix it.

In light of that, we are going to designate some of the proceeds from our seminars which are a profit center to the Association and establish a scholarship for engineering students. It will be for children of members. It doesn't matter if the person is an associate or active member or whatever, but includes anybody with membership in the B&B Association.

In the next few months, we will refine the parameters of this program and sometime in early 1995 we will have more specifics on it in the newsletter. We are working towards ensuring the future education for our children and so that there are attendees at this conference 200 years from now.

Our next presenter will introduced by Lee Hostler.

Mr. Hostler: Our next subject is a special subject on practical issues for pile driving. Our presenter, Patrick Barrett, moved here from Ireland over 30 years ago. He has a Bachelor of Science degree in structural engineering from the University of Illinois at Chicago.

In 1977, he started with the Santa Fe Railroad at Fort Madison in the engineering department. Also in 1977 he joined the system bridge department in Chicago. He has memberships in the B&B Association, the American Railway Engineering Association, the Transportation Research Board, and the Committee on Bridge Construction. He also has a Professional Engineers license in the State of Illinois.

Please join me in welcoming Patrick Barrett. (Applause)

SPECIAL SUBJECT

PRACTICAL ISSUES FOR PILE DRIVING

Patrick L. Barrett

**Engineer Construction and Maintenance
Atchison, Topeka & Santa Fe Railroad**

Driven piling has been used by railroads for over 160 years. The first recorded use occurred in 1831 in Newcastle, England, in the construction of a railroad bridge. By 1841, driven piling had been widely employed in all types of railroad structures including bridge foundations and bents, building and shop foundations, a wide variety of wayside structures, earth retaining structures and embankment stabilization.

This presentation will focus on driven piling as used in railroad bridge bents and foundations for piers and abutments. We will look at how driven piling derived their capacity, the types of driven piling generally used by North American railroads, the types of hammers and support equipment used to install piling. Next, we will discuss issues that enter into the selection of a particular pile type and its installation equipment. Then we will treat the issues of control of the pile installation process, capacity verification, and dealing with problems encountered in driving. Finally, we will discuss job site safety and environmental issues.

Although a wide variety of piling types have been devised, all piling develop their load capacity from two basic mechanisms:

- bearing piles are driven through soil into rock and the pile transmits its load directly to the rock.
- friction piles derive their capacity from the resistance to sliding along the soil in contact with the pile. Most friction piles also generate some of their capacity from bearing at the tip.

Generally displacement piling, that is, piling which move or compress a significant volume of soil, are used in friction. Examples are timber, closed-end shell and concrete piling. Non-displacement piling such as steel H piling are generally used in bearing only.

Railroad piling can also be classified into two functional groups:

- bent piling extend above the ground surface and act as columns in supporting the bridge superstructure.
- foundation piling are fully embedded in the soil under pier and abutment footings.

Historically, timber has been the material of choice for railroad bridges even after steel and concrete became widely available early in this century. In recent decades, however, both timber and prestressed concrete piling have been widely used.

Timber has several advantages including:

- lightweight and therefore easy to handle and transport.
- can be driven with lighter hammers and leads.
- is easy to cut off and work with for fitting caps and bracing, et cetera.
- railroad personnel are most familiar with its behavior and maintenance.
- is generally pressure treated for substantially longer life.
- bent piling can generally be treated in place to extend useful life.
- timber bents are generally repairable with common tools.

However, timber has several disadvantages when compared to steel and concrete:

- capacity is much lower.
- shorter lifespan.
- easily damaged during driving.
- susceptible to damage and ruin by fire.
- may be difficult to obtain in suitable lengths and quality in some areas.
- requires much greater maintenance effort.
- difficult to splice for full strength.
- treated piling may be costly to dispose of in an environmentally-acceptable manner.

Steel as a piling material offers several advantages including:

- high capacity.
- ease of splicing and cutting off.
- cutoffs are reusable.
- widely available in a range of sizes and lengths.
- low maintenance except when in corrosive environment.
- fire resistant.
- can be used with precast concrete, cast-in-place concrete or welded steel caps.

For bearing, steel H piling are very efficient when driven to point bearing within a reasonable distance. This can be 100 feet or more.

Limitations of H piles include limited capacity in friction, a tendency to tear along the flanges in hard driving, impossible to visually inspect after driving and piling damage incurred during driving may not be evident from the driving record.

Shell piling driven open ended are considered non-displacement and may be partially or fully excavated after driving and filled with concrete.

Closed-end pipe piles can develop considerable capacity in friction and/or in end bearing, can be visually inspected after driving and are generally filled with concrete after driving.

Shell piling can be easily spliced either by welding or by using friction sleeves. Welding develops the full strength of the pile cross-section and is suitable for bent piling above the ground surface and at shallow depths.

Closed shell piling are hard to drive into dense sand or gravel, hard layers near the surface, or into boulders or other obstructions. They are also limited by the availability of concrete at the bridge site.

Where potential corrosion is a concern in using steel piling, it can be addressed by specifying additional thickness, epoxy or bituminous coatings, or concrete encasement such as collars at the ground surface and normal water and splash or spray zones.

Prestressed concrete piling offer the potential for very high capacities, are relatively fire-proof, corrosion resistant and maintenance free. Their disadvantages include high weight and volume which require heavier handling and driving equipment and add to transportation costs. Greater care in handling and storage is also required to avoid damage. In northern climates, economical open air casting is limited by climate. Reliable installation requires a critical pile/hammer/cushion to match to avoid tensile driving stresses in the pile. Pile cushioning, placed directly on top of the pile, must be used to protect the pile top from damage and to evenly distribute the hammer force to the pile. Concrete piling are difficult to splice and to cut off. Most available splicing systems are proprietary. Prestressed piling have limited lateral loading resistance. For added corrosion resistance, a variety of coating materials are available.

Composite piling is the splicing of different piling materials in a single pile to suit a specific condition. For example, H-pile extensions have been welded to concrete piles in order to drive through gravel, dense layers, et cetera, and protect the concrete from damage. Other composite piles have been used using various combinations of piling materials.

A variety of proprietary mandrel driven shell piling systems are available, but have found limited application in railroad bridge construction. Their range of application and experience tend to be local or regional.

The original impact hammer is the drop hammer. A known weight is simply dropped on the pile. The earliest power source was human. Innovations resulted in draft animals as the power source and about a century and a half ago, steam was first used to assist in the lifting of the impact weight. This principle was refined into the single-acting steam or external combustion hammer. Drop hammers are slow, inefficient and seldom deliver uniform pile capacities. For these reasons, they are best suited to small unimportant foundations.

Originally powered by coal-fired boilers, virtually all external combustion hammers are now powered by compressed air. The motive fluid is introduced into the cylinder through a valve causing the piston to raise. As the piston reaches the top of the cylinder, the compressed air valve is closed and an exhaust valve is opened, allowing air to escape and the piston to drop under the influence of gravity. As the piston impacts on the pile at the bottom of its stroke, the air valve is opened allowing the cycle to repeat until the compressed air is cut off.

A further development of the single-acting steam/air hammer led to the double-acting hammer, in which the motive fluid is used to increase the gravity acceleration of the dropping piston. This greatly increased the speed of operation. A refinement of the double-acting steam/air hammer resulted in the differential acting hammer which combined the high operating speed of the double-acting with the heavy piston of the single acting.

Internal combustion diesel hammers were developed in Germany in the 1930s. After World War II, they were introduced into North America and by the 1960s were in wide use in railway bridge pile driving. They offer several advantages: self-contained internal combustion, high energy to weight ratios, and a considerable range of size and configurations allow them to be adapted to a wide range of driving conditions. However, they are considerably more complex than the external combustion hammers they replaced and require more maintenance and on-site mechanical skills for optimum performance.

Diesel hammers are simple two-cycle single cylinder engines. The single-acting diesel hammer is the simpler and was the first to be developed. A crane line is used to lift the piston which is then allowed to fall within the cylinder compressing an air and diesel mixture. Upon ignition, which coincides with impact, the fuel mixture explodes and the combined energy of impact and explosion propels the pile into the ground and the piston upwards in the cylinder. As the piston passes the ports in the cylinder wall, the combustion products are exhausted. The upward movement of the piston is arrested by gravity. Once the hammer fires, this process is repeated automatically until the fuel source is interrupted.

The double-acting diesel hammer is identical to the single acting in starting and combustion. The top of the cylinder of the double-acting hammer is closed and the top of the piston is equipped with compression rings so that the volume of air at the top of the hammer is compressed as the piston rises. This speeds up the operation of the hammer considerably by arresting the piston stroke and the resulting air pressure accelerating the piston on the down-stroke.

In order to control the hammer and to verify energy output, a means is provided to observe the air pressure at the top of the cylinder. Manufacturers provide charts and graphs relating air pressure to hammer energy for various air hose lengths. Double-acting diesel hammers provide greater energy to weight ratios and cycle faster than equivalent single-acting diesel hammers. However, they require more maintenance, must be carefully matched to local driving conditions and can be difficult to use should unexpected driving conditions arise.

The vibratory pile hammer consists of rotating eccentric weights set in resonance with the ground. It may be either electrically or hydraulically powered. It can be highly efficient in penetrating granular soils but is unable to penetrate many cohesive and mixed soils.

To date, no reliable means have been developed for determining the bearing capacity of vibro-driven piling; therefore, they may be used for bent and foundation piling only if capacities have been determined by load tests. Vibro-drivers are now mainly used for installing sheet piling where bearing capacity is not important and where they can be used to extract (by reversing the direction of motion of the eccentric weight) sheet piling used as temporary shoring.

Hydraulic impact hammers have very recently been introduced. They share many similarities with steam/air hammers including an external source of energy in the form of an hydraulic power plant. Three basic types are available: gravity free fall, hydraulically assisted free fall and nitrogen assisted double acting. They are expensive and so far have seen very limited use in railroad pile driving.

To support the pile and hammer during pile spotting and driving, several choices of pile leads and carriers are available. The simplest lead system is the swinging leads, also referred to as hanging leads. The lead structure, usually in the form of a U-shaped steel frame, is suspended below the boom tip, either by a crane line or a link. Crane line suspension allows the leads to be easily removed from the crane thus freeing the crane for other uses. The leads must be longer than the combined pile/hammer length as the bottom of the leads must be supported on the ground or bridge deck unless the pile is supported independently of the leads. Thus swinging leads generally require long booms to accommodate longer piles.

Swinging leads are inefficient on rail mounted cranes as on-track cranes have limited capacity and are usually equipped with short booms. Swinging leads are also difficult to transport on rail-mounted cranes. It is also difficult to set accurate pile batters with swinging leads when the piles are not independently supported. Swinging leads are most efficient when driving vertical piling, where piling are staged close to the driving location and where several piling can be driven with minimal crane movement. Thus swinging leads are well suited to off-track cranes which are capable of supporting longer booms, have larger capacity and operating sectors, and are engaged in driving large pier or abutment layouts.

Another common lead system is the fixed leads in which the lead frame, typically a box structure similar to the swinging leads, is pinned to the boom tip and supported near the bottom of the leads by a brace connected to the carrier which is usually a crane. The brace stabilizes the leads and allows driving piles which extend below the leads without additional support. Depending on the construction of the brace fore, aft, and side batters may be set. Fixed leads may extend past the boom tip allowing longer piling to be driven.

On-track fixed lead straight locomotive pile drivers were common on railroads until quite recently. They offered quick set up for driving once at the driving site, the advantages of on-track movement and efficient preparation for movement to a siding. They could be readily moved in train under railroad control. Their main drawback was that they were a single use machine as they were of limited utility in unloading and staging bridge materials. In those days, bridge construction usually required the services of a crane and a pile driver.

In recent years, straight on-track locomotive pile drivers have given way to the more efficient on-track combination crane/pile drivers. When extended above the boom tip, up to 60 feet of leads can be mounted on a typical locomotive crane. With extendable braces at the bottom of the leads, they can be configured for forward batter, and with moon beams or parallelograms, either mechanically or hydraulically operated, they can drive side batters. The utility of these machines is evident in their ability to serve as both pile driver and fully functioning on-track locomotive crane. When rigged as pile drivers, the leads can readily be folded under the boom for movement to and from the job site.

Drawbacks of the fixed lead pile driver include the following:

1. Pile length is limited by the length of the leads and bridge center height.
2. The batter setting process can be cumbersome, time consuming, and very limited to a few preset batters.
3. It is very difficult to set compound batters with respect to the bridge if the crane upperworks must be rotated from the centerline of the track.

Introduced in the last 20 years, semi-fixed leads allow the lead column to raise and lower independently of the boom, thus allowing longer piles to be driven. They are equipped with versatile hydraulic bottom braces or kickers by which the operator can set a wide variety of forward, aft, and side batters as well as compound batters with respect to the bridge. They fold under the boom for travel similar to fixed leads. They are more versatile and efficient than either swinging or fixed leads. Semi-fixed leads require more maintenance than either swinging or fixed leads and when mounted on locomotive cranes must be used with care over the side of the crane when the outriggers are not set.

We have seen that on-track locomotive crane/pile drivers are widely used for supporting the pile leads, hammer and pile. They offer the advantages of substantial capacity over the ends, where in-place bridge renewal piles are mostly driven, direct access to the bridge site over rail, and can be readily converted to crane for material handling, removing and existing bridge structure and installing its replacement. They are transported under railroad control. They are well suited to rebuilding washed-out track as they generally can drive one or two bents ahead of the crane location. For this type of emergency, their being rail mounted is a distinct advantage.

The drawbacks of rail-mounted locomotive crane pile drivers include limited capacity over side without outriggers, and thus are not suitable for driving offset alignment bridges. They must travel from a siding to the bridge site and back within the working window. In high density single track territories, lack of suitably long windows may lead to poor productivity.

The most common off-track carrier is a crawler crane equipped with swinging leads. They can also be equipped with fixed or semi-fixed leads. They are best suited for driving offset alignment bridges. When driving through an existing bridge, they are limited by boom length and bridge center height. If swinging leads are used, pile length is limited by boom length and the difficulty of supporting the bottom of the leads on the bridge deck or ties.

An important consideration in the selection of piling types and pile driving equipment for railroads is the ability to quickly respond to emergencies such as fire, washout, and bridge damage due to derailment. Thus railroads tend to standardize bridge designs around a minimum of piling types and pile hammer capacities. This approach also takes advantage of the fact that most existing bridges are based on standard designs. This is particularly true for timber trestle bridges, which generally have the shortest life span and are the most vulnerable to fire.

Standard design bridges are economical as they require less diverse equipment and procedures and offer savings by allowing ordering in quantity when used in programmed bridge renewals. Thus a quantity of additional emergency stock can be secured at minimum cost and strategically stored. For the rare severe emergency, standard material may be diverted from programmed renewals so that a bridge can be restored to service with minimum delay.

Standard design bridges suffer drawbacks in that they may not be the ideal and most economic bridge for a particular location, even though they may be designed with alternative friction and bearing pile foundations. Also standard design bridges may be difficult to install in borderline formations. Nevertheless, their overall economy, flexibility, and potential for highest utilization of forces and equipment outweigh these disadvantages.

Numerous factors enter into the process of selecting a particular pile foundation and proposed pile lengths including the following:

1. Permanent or temporary construction. Permanent piling foundations are designed for the renewal or permanent repair of existing structures and the emergency rebuilding of existing structures. Temporary construction includes shooflys, helper piles and bents and temporary repairs due to emergencies.
2. Design loading.
3. Historical records of proposed bridge site.
4. Behavior of other structures in the vicinity or in similar geologic formations.
5. Results of subsurface investigations.
6. Test pile results.
7. Results of dynamic pile driving formula studies.
8. Results of wave equation analyses.
9. Results of pile load tests.
10. Relative costs of alternate designs.
11. Availability of suitable material, equipment, and labor.
12. Maximizing productivity of available resources.
13. Experience of design staff and pile driving gang in the region of the proposed bridge.
14. Rail traffic density and patterns.

Sources for the review of historical records include high water records, scour records, past problems at the site or geologic formation and pile records of previous structures at the site and in the area. Other possible sources include local geologic and subsurface exploration reports, aerial photographs and related articles in geologic and engineering journals.

Subsurface investigations consist of borings through soil into rock for the purpose of performing field tests and obtaining samples for laboratory testing and analysis. Results of these efforts should reveal the following:

1. Location of ground water table, at least to the extent that it is within the zone of influence for the proposed foundation.
2. Bearing capacity of the soil.
3. Soil and rock properties.
4. Data to make settlement estimates.
5. Data to evaluate alternate foundation proposals.
6. In seismic areas, evaluate liquefaction potential of the solid strata and its effect on proposed foundations.

Test borings should be made at enough locations and to a sufficient depth below anticipated pile tip elevation to determine adequately the character of the material through which the piles are to be driven and the material underlying the pile tips, and disclose any important irregularities across the site. Field tests such as the standard penetration test are generally incorporated with the test borings.

Soil testing may be omitted for unimportant structures or where reliable information is available from other sources such as historical records, test piles or pile test loads.

Studies incorporating data from soil investigations and using traditional pile driving formulas may be helpful in selecting pile foundations. Many so-called rational formulas have been developed in the last 100 years, but almost all require some empirical input or judgment. The most common is the Engineering News Formula developed in 1888 for timber piling. Several formulations are available for steam/air, drop, or diesel hammers. It includes a safety factor of six and should not be used outside the capacity range for which it was developed. The Modified Engineering News formula attempts to account for the relationship between the weight of the driving mass, the piston, and the weight of the driven mass, the impact block and pile. The Hiley formula was the first rational formula that attempted to take into account all sources of energy loss in the driving process.

The wave equation is a recent development that uses a computer to compute the energy relationships and losses in pile driving. It requires substantial input which must be obtained from soil borings and laboratory analysis. It can be used to estimate several aspects such as:

1. Optimal matching of the pile/hammer/cushion system to the soil. This can be very useful in designing prestressed concrete pile foundations as pile stresses can be estimated.
2. Estimate final driving criteria such as blow count and energy.
3. Evaluate actual driving results. Test pile results can be compared to those predicted by the wave equation analysis and adjustments made.
4. Estimate capacity and driving requirements for other depths.
5. Appraise alternate hammers.

Test piling may be considered where variable soil conditions are known to exist. The number of test piles depends on the extent of the structure, its importance and the results of first test piles driven. They are driven before other service piles are ordered and are driven deeper than required for service piling. Careful records for each foot of penetration should be taken. They can be located where they can be later used as service piles in the structure.

Pile load tests may be considered for large, important structures or where unfamiliar subsurface conditions exist. They provide the best knowledge of individual pile capacity, when carried to failure on a pile driven to service pile criteria. Load tests should not be performed on test piles.

In addition to the wave equation, several guidelines are available to assist in matching a given pile with a required capacity to an appropriate hammer. One common rule of thumb states that the ratio of driven weight to piston weight on an impact hammer should be between one and four. The AREA Manual for Railway Engineering provides guidelines to match hammer energy to required pile capacity and pile material in Chapter 8, Part 4.

Care must be exercised in spotting the piling accurately, establishing specified batter and maintaining this alignment during driving. The leads and carrier should not be relied upon to maintain pile alignment. Trying to realign a drifting pile using the lead or crane controls seldom is sufficient and can cause heavy energy loss and pile or equipment damage. Severe crowding of the pile using the crane swing control can be dangerous as the resulting side loading on the boom could cause the boom to collapse. When driving through existing bridge structures, driving templates can generally be installed using the existing structure for support. For optimal control, two sets of templates should be constructed, one at deck level and one close to the ground surface. Small pilot holes may be dug in the ballast or ground surface when driving through the roadbed or embankment.

Once a pile has drifted out of alignment tolerances, it must be pulled and redriven or a replacement pile driven, taking care not to interfere with other piling in the structure. Slightly misaligned bent piling can be pulled before installing the cap. Pipe piles must be pulled before filling with concrete. Additional reinforcing such as bent bracing or groundline collars may be advisable.

A common problem encountered in pile driving is heaving of adjacent piling. This occurs more frequently, but not exclusively, to displacement piling. It is also more common in pier and abutment pile arrays than in bent piling. It is a problem every pile driving supervisor must be alert for as heaved piling can lose a substantial portion of their capacity. Driven piles should be marked or elevations taken on a regular basis. Heaved piling must be redriven and monitored. Heaving may be minimized by starting driving at the center of the layout and working towards the edges.

Inadequate penetration due to unexpectedly hard layers, cobbles, or boulders can be resolved by preboring if the obstructing layer is at shallow depth or by jetting. Water jets can be used alone or in combination with driving to achieve the desired penetration and then the pile driven to bearing.

Inadequate penetration may also result from poor hammer performance due to poor maintenance, worn cushioning, unsuitable cushioning or inappropriate attachments such as pile helmets and adapters.

Friction piling occasionally encounter a formation where the resistance and pile capacity indicated during driving reduces with time. This condition is known as relaxation and occurs in some granular soils. An opposite effect is sometimes encountered in cohesive soils. In this condition, the friction pile gains resistance with time. This is known as freeze.

To guard against relaxation, a representative sample of friction piles should be retapped after several days. If freeze is encountered, it is important to avoid interruption in the driving of each pile.

It is important to strictly follow the engineer's driving criteria and instructions and avoid inflicting damage to the underground portion of the pile especially solid piling which cannot be visually inspected. Possible indicators of underground damage include:

1. Pile twisting.
2. Pile drifting.
3. Intermittent drops in blow count concurrent with an increase in penetration under hard driving may indicate that the pile is buckling underground.

Any disparity between expected and actual driving such as penetration rate, hammer energy blow count, stroke, et cetera, should be investigated and the probable cause determined.

A common cause of pile damage is overdriving. For various reasons, the specified hammer or energy is too much and the pile suffers. Part of the problem is related to older hammers, diesel hammers in particular, with inadequate means to adjust the energy input while the hammer is running. Modern diesel hammers can be fitted with remote throttles allowing the energy input to vary as the pile is driven.

Steel H-piles can be protected from damage by tearing along the web by using hardened cast steel driving points.

Various methods are available to verify that the pile as driven has achieved its intended capacity. The usual means is to specify driving criteria such as minimum tip elevation, minimum blow count and associated hammer energy, hammer speed, or minimum capacity as computed by a pile driving formula. Several of the above items may be specified.

Some hammers can now be fitted with instrumentation which can detect and store a record of energy input, penetration, piston stroke and blow count.

A recent development in pile driving verification is the Pile Driving Analyzer, or PDA, which can be used to estimate the ultimate pile capacity as the pile is driven. Accelerometers

and strain transducers are attached to the pile. Wires from each gage are collected at a connection box which hangs from the hammer by a chain. A single cable runs from the connection box to a portable computer located on the ground. The computer analyzer converts the data into force and velocity versus time graphs and displays them on an oscilloscope during driving so that the quality of the data can be evaluated. The PDA can be used to verify the results of the wave equation and driving criteria and can also detect broken piling and indicate certain types of pile damage.

A record of the driving of each pile should be made at the time of driving and kept on file. This record is essential for determining the cause of any future problems and can be used to evaluate soil conditions at other sites in the vicinity. This record should contain all the following information:

1. Date.
2. Hammer model and attachment details.
3. Bridge identification.
4. Pile batter.
5. Cut-off elevation.
6. Ground elevation.
7. Tip elevation.
8. Pile Type.
9. Depth of preboring or jetting.
10. Blows per foot for entire length of test piles.
11. Final driving criteria for service piles.
12. Length of substantial interruptions.
13. Unusual occurrences and depth at which they happened.
14. Name of the person taking the record.

The safety risks and potential for accidental property damage and personal injury at the pile driving job site unfortunately be considerable. Careful management of these risks must be of the highest priority in the planning, staffing, equipment selection, scheduling and execution of all tasks in the operation.

Elimination of known hazards is the first and most effective step. Here proper equipment maintenance and inspection is essential. Daily inspection of critical crane and hammer components must be diligently conducted, loose bolts tightened, and defective wire rope, slings, fittings removed from service. Holes in bridge decks must be covered as soon as the work moves to another location.

When known hazards cannot be eliminated, they must be guarded so that personnel are protected. The work area must be protected so that only essential workers are admitted.

If workers must be exposed to hazards in the performance of their duties, appropriate warning and instructions must be posted. The warning placards on newer cranes regarding working near high voltage electrical power lines is an example.

Proper training of workers is also essential to managing safety. The crane operator must be thoroughly familiar with the operation of his machine, its capacity and operating sectors, the pile driving equipment and its effect on crane capacity, machine maintenance and all pertinent manufacturer's instructions and warnings. Similarly, each person on the pile driving gang must be thoroughly familiar with his assignments.

As it is impossible to eliminate or guard against all hazards, personal protection is the last safeguard. Hard hats, steel-toed boots and safety glasses are essential. Hearing protection should be required while the hammer is running. Fall protection must be employed on high bridges and when it is necessary to climb the leads or crane boom.

Finally, a thorough knowledge and strict observation of safety rules encourages an attitude of awareness and personal responsibility that is also essential to managing safety. Several sources of pertinent safety guidelines and rules are available such as equipment man-

ufacturers, Federal and State Occupational Safety and Health Administrations and the railway's own safety rules.

Depending on the pile driving location, any or several of a wide range of Federal, State, local or regional environmental, conservation or similar agencies may have or claim jurisdiction. These include the Federal EPA, local State EPA, local city or county environmental departments, water agencies and fishing, wildlife and wetland preservation agencies. It is the responsibility of the property owner to determine which, if any, of such authorities has jurisdiction and to comply with applicable regulations. The interpretation of these regulations is not always a straightforward matter and in some cases permits are required. Penalties for non-compliance may be severe and may subject the property owner to criminal and civil charges. Since compliance may limit foundation and equipment choices, work procedures and schedules, these matters must be addressed early in the design.

In some areas, there has arisen a class of consultants who specialize in interpreting local regulations, negotiating with the agencies, securing permits and furnishing the necessary compliance documentation.

Some equipment manufacturers have adapted their equipment so that low polluting fuels and lubricants can be substituted for diesel and conventional lubricating oils. Others have incorporated technology such as pressure fuel injection which pollutes less than conventional splash fueling.

As we have seen, the practical issues for pile driving are considerable and challenging. However, we can foresee with confidence that pile driving will continue to be an essential technology for railway bridge and structure foundations well into the future. (Applause)

Mr. Van Huis: Our next presentation is dealing with air leaks. The presenter is Kelly Pathol, technical manager for PSSI, a New York based company providing training, workshops, and compressed air steam and boiler systems.

PSSI also conducts in-plant surveys and studies of compressed air and steam systems. Mr. Pathol graduated from the University of Wisconsin and has been involved in steam and compressed air systems for more than 20 years with many articles published on steam and compressed air systems. Mr. Pathol is considered one of the top experts and troubleshooters for compressed air systems. Please join me in welcoming Kelly Pathol. (Applause)

DEALING WITH AIR LEAKS

Kelly Pathol
Technical Manager
PSSI

On the conference schedule you will notice that Bob Snyder is listed as the speaker for this subject, however, he is not going to be here today.

I have been around compressed air systems for about twenty-some years now. Everybody thinks compressed air is free. Air is a gas. It is free when it's a gas. However, when air is compressed at 100 psi, it becomes a utility and now it costs us money to produce it. Take for example: a 1/4 inch diameter leak in a 100 psi air line is equivalent to 289 light bulbs left on year round.

I want to conserve energy. At times I have walked into facilities and heard air leaks. People think air is free. Air is not free. Air, in fact, is one of the most expensive utilities that

we have in operation today. Not only does it cost us money and energy, but it also costs us loss of production and quality control because they are not moving air cylinders to their correct position.

Why do we use compressed air? It is safe and economical. It is adaptable and easily transmitted down through the facility and the Environmental Protection Agency hasn't classified it as a hazardous waste yet.

With regards to compressed air systems and power sources, we have multiple compressed sources, control systems, intake air filters, cooler separators, air receivers, air driers, and distribution systems. The reason I list out all the components is these are all points that can cause leakage of compressed air which is a loss of energy. Compressed air is a very expensive form of energy as I just explained.

We just conducted a study for an air facility with 14,000 CFM of air. We fixed their air leaks and now they are running at 6,500 CFM of air. They project a first-year savings to be in excess of \$300,000.

Compressed air is not cheap. Compressed air represents approximately 10 percent of all industrial electric usage so when you take a look at your electrical bill, 10 percent of that is typically for your compressed air system. Over a ten-year period of time, air costs are 75 percent energy, 15 percent capital, and 10 percent maintenance. I go out and I buy a \$150,000 air compressor and put it in my plant and then I walk away from it and forget about it. I just purchased this \$150,000 compressor. It is energy efficient, but in essence, 75 percent of that money is for the energy to run that compressor for the next ten years.

It is estimated that 30 percent of all air produced is wasted and could be saved by simple cost effective energy efficient measures such as leak detection and correction. So over that ten-year period of time, 30 percent is very conservative to say the least. I have been in a facility where in excess of 70 percent is lost.

To improve efficiency and save energy, it is necessary to understand and evaluate each merit or component that makes up the compressed air system.

When we go into a facility, how do we find air leaks? They are costing us a lot of money, but how do we find them? We can go out to a facility and listen. Have you ever walked through your facilities and listened? You can hear the air leaks, but to send out your maintenance people to listen for air leaks, they grow very tired of that pretty fast.

The other way is using what is classified as a soap solution. You go out with a bottle of soap and soap up all of the fittings to find a leakage. That has a drawback because you have to carry a bottle of soap around and you are soaping up everything. People get tired of looking for the bubbles coming through the soap solution.

Another way is going around and feeling for air leaks. For gross air leaks, you can find them this way, but for the small 1/4 inch or 1/16 inch air leaks which is costing us probably \$5,000 a year, it is not very easy to find.

That's why I want to show you what I brought here with me today. It is an ultrasonic unit. It is a sending and receiving unit. The receiving unit receives ultrasonic frequencies. Anything that is passing through a restriction will give up ultrasonic sounds and this device will pick it up. It works at a frequency range up to 20 to 100 kilohertz. The human ear can hear up to 18 kilohertz. We look at a frequency above the human ear. That way, I can walk into the facility with the plant in operation and point out and find the ultrasonic source.

The second thing with sound at 20 to 100 kilohertz is it is very directional. That's between 0 and 18 kilohertz. It goes all over the room. It's a very small band. The device is very portable. We use it and have been using it for ten years. This unit came onto the market about six or seven years ago.

On the back of the unit, there is a sensitivity dial, but not volume control. I can make this unit very sensitive and find a leak 1 times 10 to the minus 4. What does that mean? Well, if you are familiar with soap solutions, that's one bubble every two hours so you can find

very minute leaks. But the unit has a sensitivity dial and you can desensitize it and find your gross leaks.

Underneath you can change the frequency to look at different frequency bands so that if you have gas and air leaks, you can tune out the gas leak and pinpoint the air leak. It is very easy to use. It doesn't take a space shuttle scientist to figure out how to use it. This way, the maintenance people out there are going out and doing the work relatively easily.

I happened to bring an air leak with me. The procedure is you go to a facility and you scan. The ultrasound is very directional so now you can pick it up. It is that easy to go out and find air leaks. The other thing is the air unit comes with a stethoscope module so you are finding ultrasonic sounds. That is the reason we use the unit. It is FM approved and it can go into any explosion-proof area and can detect any other type of gases, freon, refrigerator gases, et cetera.

Air costs a lot of money. Going out to a facility and finding four air leaks will be a savings of \$7,000 per year, conservatively, and we all think it is free. The thing is, leaks are very difficult to find in a facility. We have a lot of other noises going on. This unit gives you the ability to compete with the other competing ultrasounds to go in and pinpoint and find air leaks. Basically it is that simple.

The unit costs approximately \$4,000, but it has several different applications with locating air leaks being just one.

The point I want to get across is that air does cost a fortune to produce. Thank you. (Applause)

President Steele: Before you leave, I would like to make sure you fill out the conference survey cards. It will help us with the agenda for next year. Please fill out the special subjects for next year as well and perhaps volunteer to help. There are some good subjects on there and we hope to get a good response out of it.

I want to thank all the people who gave presentations today. I know they went to a lot of work to put them on because it takes a lot of effort and a lot of time. I also want to remind everyone that at 7:00 o'clock tomorrow morning, REMSA will have a coffee bar set up right here in this room. We will adjourn for tonight and start again tomorrow morning at the joint session. Thank you. (Adjourned)

JOINT SESSION

Tuesday, September 20, 1994

President Schubel: Good morning. The second joint session of the Roadmasters and Maintenance of Way Association of America and the American Railway Bridge and Building Association will now come to order.

One definition for a conference is "meetings in which people talk about what they should be doing back on the job." You can interpret that a couple of different ways, but what you are going to hear today is going to help you in your job and help you as a person to deal more effectively on your job.

There are a lot of good presentations on your program. See what is on the schedule today and be sure to attend. We have Harris Wagenseil, Jolene Molitoris, and Ed Butt with us this morning. We have some good presentations in the panel discussion on work equipment and preventive maintenance. The session on stress management is certainly one that you should sit in on. Billie Terrell is a very dynamic speaker and I think you will get a lot out of her presentation.

This afternoon we have breakout sessions that include FRA track inspection, signals, and bridge basics for track maintenance employees.

I would like to ask our directors to pass out the survey forms so that you have those this morning. We appreciate you filling these out and giving us your comments. There are sign up sheets for next year's topics for anyone who wishes to work on these committees, volunteer to supply information, or actually chair the committees. We really appreciate your getting involved in these committees.

Conference registration numbers this morning show 235 roadmasters, 84 B&B, 174 suppliers, and 82 spouses, for a total of 575.

With that, I would ask the president of the B&B, Don Steele, to come up to the podium.

President Steele: Thank you, Gene. Good morning. It is my pleasure to introduce Harris Wagenseil, vice-president of maintenance operations at Union Pacific Railroad.

Harris joined the railroad in July of 1989. He received a Bachelor's degree from Dartmouth College in 1967, summa cum laude, and was a member of Phi Beta Kappa.

After college, he attended Oxford University on a Rhodes scholarship and earned an M.A. degree in the honors school of politics, philosophy and economics with emphasis on economics. Harris then received a J.D. degree from Harvard Law School after which he practiced law in various public and private capacities. After practicing law for several years, Harris then received an M.B.A.

Harris joined Cummins Engine as vice-president of automotive in 1983. His last assignment with Cummins was as vice-president of business development. Upon joining Union Pacific in 1989, Harris served as assistant to the chairman where he was responsible for Union Pacific's business with Mexico and for the installation of an integrated planning and control system to improve the railroad's management system which is still being used today. Harris was appointed vice-president of supply in July of 1990. In February of 1991, due to downsizing and reorganization, he also took on the responsibility of the maintenance operations department.

Over the years, Harris has served on boards of several corporations and public interest associations. He has been a speaker and lecturer at various conferences and meetings throughout the years. So with this, I give you Harris Wagenseil. (Applause)

KEYNOTE ADDRESS

Harris Wagenseil

**Vice President Maintenance Operations
Union Pacific Railroad**

Thank you, Don. Good morning. I am honored to be with you here this morning and flattered by the invitation to make one of your keynote speeches.

Since receiving the invitation, I spent some time thinking about what I wanted to say. I thought about doing the vision thing, but I thought with a lot of engineers in the audience, that might be too broad a brush. (Laughter)

So I thought about just focusing on technical issues and honestly that just seemed to be downright boring. If you bear with me, I am going to do some of both. I am going to mix together a vision of the industry and we will also get into some technical details. I will give you my thoughts on where the industry is today and what I think we need to do in the future. Along the way, we are going to talk a lot about technology that has significant implications for track and bridge functions.

Over the past few years, we railroads have had a pretty good run. This slide shows operating numbers since 1987. The eastern and western major roads are grouped separately and all Class Is are shown. Although the industry has had its ups and downs, it has generally strengthened for the major roads. Operating income is up 23 percent from 1987 to 1993. Some of the regional roads which are not shown here, in fact, have even a better experience and done significantly better.

As this slide shows, in the last couple of years particularly the operating ratio for the major railroads has declined generally although some Class Is have seen their operating ratios decline steadily since 1987. The upward trend from 1989 to 1991 in the western group and for the Class Is as a whole is heavily influenced by the Southern Pacific experience. In particular, however, the Union Pacific, Santa Fe, Conrail and Norfolk Southern have notable downward trends in their operating ratios if you look at them separately. Overall, the Class Is have declined two percent, although in the east, the operating ratio is down three percent.

Now, how have we accomplished these results? Surveying the past ten years or so, an analyst for Donaldson Lupkin noted in a June 20, 1994, report on rails, "The industry has significantly and permanently reduced its cost of production by eliminating excess capacity and unproductive work rules carried over from more than 100 years of government regulations. Since 1980, the railroads have exceeded 80,000 miles of track or approximately one-third of the original line, reduced rolling stock by 50 percent, and eliminated more than 50 percent of the employee positions."

Where are we now? Let's turn to another analyst, Jack Kawa of Dean Witter. He wrote in June, "The industry enters a new era of expansion, hiring, and shortages. Uncharted territory after 15 years of surpluses, not sure of the impact, there will be some, after 15 years of downsizing, we wonder what impact an expansionary mindset will have on overall profitability. This is clearly an unknown for both management and analysts."

The firm of C.S. Boston makes the point more strongly. "As we have discussed in numerous previous reports, we believe the easy cost cutting for the railroad industry is largely behind it. Rail cost reduction opportunities are becoming more limited." Let me just repeat that. "The easy cost cutting for the railroad industry is largely behind it. Rail cost reduction opportunities are becoming more limited." So the bottom line is we have had a pretty good run the last few years and the supply industry has had a pretty good run, too, and their good times have returned.

The situation we face now, however, is that we have squeezed out much of our excess line capacity, our excess equipment capacity, and a lot of our excess people. Consequently, we will not be able to use the same tools, at least to the same degree, in the future that we have used already in the past.

Now, the picture that I have just painted is a familiar one to most of you. There is one more element that I think is critical, however. This has to do with our cost of capital. Mercer Management, who did an excellent series on the industry, observed in *Progressive Railroading* recently, "Since 1986, with the cost of capital consistently pegged at around 11.5 percent by the ICC, the industry's rate of return on net investment has never exceeded 8.1 percent and only a handful of individual railroads have earned more than their cost of capital."

I asked our finance department to look at the same issue in preparation for this speech and here is a composite graph that they have prepared for me. It shows the industry cost of capital as the yellow line on the top and the total industry return on investment as the bottom line. As you can see, there is quite a gap between the cost of capital and what we have managed to earn on the total net investment. The year 1991, by the way, was a big dip. That doesn't reflect really all the facts since a lot of railroads chose 1991 to make major write-offs. The performance is actually better than is shown.

This next graph shows the industry cost of capital as the yellow line on the top and then there are a host of lines charted representing the big seven railroads. You can see that very few of those other lines break above the yellow line in any single year. There are very few that rise above the yellow line with any kind of consistency. The message here is that despite our excess capacity, despite our recent successes, we have had trouble earning the cost of capital invested in us. Over the long-term, this will result in depressed stock prices and lack of further investment. I personally think this is the number one long-term strategic issue facing the industry. We can justify buying a locomotive or some freight cars based on the return on investment, but as we become more capacity constrained and investment in several inputs are required simultaneously, the question is how and when will we earn our cost for that capital. These are really pretty serious questions and I will give you some thoughts on things we can do to help improve our returns.

The folks at Mercer Consulting have their answer to the cost of capital issue and that's worth reading. This morning I will put my particular spin on it. What do we do next? I have three very simple recommendations, and they are all related:

1. We need to sharpen the tools we are using and to improve our asset utilization.
2. We need to shorten the cycle time for the introduction of new technology in the industry.
3. We need to cooperate and work together better than ever.

So what does this mean? Firstly, I think that we cannot shrink ourselves into prosperity. I suspect and fear that some railroad organizations have been so accustomed to cost cutting that perhaps we have become shortsighted. I know we have a lot of technology that is coming, such as AC locomotive, electronic freight car brakes, and so forth. I will return to those topics in a second. But I fear some of us have become a little short-term in our focus and I will remind you as one author writing about Ford Motor Company in the 1960s said that the idea that companies seemed to have at that time about cost control was to take an inch off the tailpipe each year. We cannot afford to use a little thinner castings in our components or take an inch off the air brake hoses each year if we are going to be successful in the long run.

Instead, we need to invest new resources, or redeploy our current resources, into developing a better understanding of how to use our assets more effectively. We need to join with our suppliers to use a common approach in language based on rational analysis. You don't have this to the same degree that we do; but we need to use the same approach where interchange standards are concerned.

. What do I mean here by sharpening our tools in order to improve our asset utilization? If you bear with me, I am going to give you one or two examples and these are from the mechanical area. Firstly, the Field Manual and the Manual Standards and Recommended Practices govern our freight car management. These rules are the result of numerous industry meetings and they state what we are required to do. Many of them are also incorporated into the Federal Regulations and they have become law. If you look in these manuals for a rule, for example, on when a freight car roller bearing has exceeded its useful life, you will look in vain because it is not in there. What is in there is a rule that says if an axle is removed for any reason, for example a worn-out wheel or a shell tread, then the bearings must automatically be reconditioned. Although I am sure all of us would agree that at some point bearings are going to be in need of reconditioning, our own Manual of Standards and Practices says that wheel condition or axle condition is going to be the signal as to what the right time is to condition the bearing. I have no idea how we ended up with this rule.

It reminds me of what a French revolutionary said about laws, "they are like sausages; you really never want to watch them being made. Anyway, the result here is quite a mess of leftovers in my judgment, that are packaged together. Here is one more example in the mechanical area. This one concerns traction motor support bearings. The manufacturer suggests that we change our motor oil annually for support bearings. We don't do that, however, and we don't do it because we have found that the more we fool around with removing and replacing support bearing wicks, the more failed bearings we have. However, on some motors we do get by with just sweetening the oil and waiting for the wheels to wear out. We asked for technical advice from our supplier on this. They responded that the greatest factor influencing our failure rate was not following their recommendation to change out the motor support bearing oil for all traction motors on the schedule they require, as all other railroads appear to be doing.

Again we scratched our heads over this because on some motors it works and on some motors it doesn't. So we got very confused. Someone gave us the idea of putting in an oil additive. We did that and then stood back to see if it made any difference. We couldn't tell if it made any difference or not. The bottom line is we wasted a lot of time by confusing ourselves and playing around with different things.

What I would like to do is illustrate a better approach and this is the one that we eventually used. It involved some tools of the kind that I'm talking about. In this instance, we called Duane and Weibull Analysis. We used them to evaluate the useful life and failure modes of the traction motor support bearings. As a result of our tests, we found out a lot about the difference between the two motors and our maintenance practices and we also figured out that the oil additive that we put in didn't make any difference.

This is a Duane plotting model which was used to chart cumulative failures against cumulative days. In order to generate a straight line on this, both scales, X and Y are logged. What this model provides is a method for evaluating overall system reliability.

If the system reliability is constant, the slope should be one. If the reliability is improving, the slope will be less than one. If the reliability is increasing, it will be greater than one.

This model was quite helpful in identifying differences between different facilities performing the same assembly task. You can also evaluate the effect of more training or putting more people on the job and see what happens to the slope of this line. Now on the plot that is shown here, you can see a point of inflection. That was at approximately 10,000 cumulative days. This happened to correspond to a time when we made a change in our traction motor combo assembly procedures. So although we made the change in order to decrease our costs, what happened was a decrease in the reliability of the component.

The next thing we did was to perform a Weibull Analysis on the support bearings for the different motors. We got at least two different types of traction motors. Weibull can be used for a specific component and will show you in a probabilistic manner how the mileage and time and so forth affect the failure rate of the component.

In this plot what you see is actually two different motors and two plots for each motor. The top line is one motor and then there is a bottom line here that then curves upward also. Those are two different motor types. This is called a Weibull distribution and it shows two failure modes associated with a component. The lower slope is the first stage of failure and the second steeper slope is the final wear out mode. Since the slope of the lower part is less than one, it is referred to as an infant mortality mode. Where the line becomes very steep, it is referred to as a rapid wear out failure mode. On the Y axis is the probability of failure in percent and on the X axis are the miles that the components have traveled.

The way to interpret the lines for the top traction motor is that if you run these motors to about 220,000 miles you will find there is about a two percent probability of failure. If you run to 335,000 miles, there is a five percent probability of failure. That sounds like it is pretty good, but if you look at the bottom traction motor, the bottom set of lines, you will find that you can go 370,000 miles with a two percent failure probability and 430,000 miles with a five percent failure probability. So with one motor type you can run an extra 100,000 miles or so with the same basic failure rate.

The other thing to notice is the slope of these two curves. The bottom part is roughly the same which means that the failure modes are roughly the same. The difference then is likely to be in the design. If we were doing this right and we were trying to run at a two percent probability of failure we would stick with one motor at 220,000 miles and with the other at 350,000 miles. Of course, the problem is we don't. We didn't do that. We maintained that the two motors are the same with different failure rates. We didn't understand why one motor was failing earlier than the other.

What you are seeing here is that by using this type of analysis, you can determine the probability of failure for a variety of components and you can tailor your maintenance practices accordingly.

Now these are the types of tools that I think we need to use more often. As an industry I think that we cannot afford to test a new component anymore by installing it on a freight car, for example, and running it around for a while and seeing how it does. We have done that a lot. Both the railroads and the suppliers need to use this type of tool so we can sharpen our dialogue and improve our asset utilization. It will also enable us to talk a lot more factually about our problems and gain a better understanding about maintenance and design of our components and improve the overall reliability of our transportation product.

I don't know if these kinds of tools are in use in the engineering or bridge areas at all. I would suspect that they may be susceptible to those fields just as they are in mine and certainly, of course, in work equipment you are talking about mechanical issues as well.

Incidentally, I learned a couple of days ago that Jolene Molitoris is going to be speaking after me. I might just add one further word about these tools in the context of FRA regulations. Personally, I think with these kinds of tools you can set performance standards for your equipment and in this way you can achieve regulatory goals of safety or health or efficiency or whatever. From my standpoint it would certainly be a lot better than the command and control type where you are down to measuring centimeters and inches and so forth as to whether or not you comply. I would like to see the FRA step back and use more performance standards, allow us to use analytical tools like these, and our own ingenuity and creativity to achieve the social goals. Frankly, you would have fewer people in government there just to see if we meet the performance standards or not. It would probably be cheaper for the government as well.

Anyway, my second theme here is the need to reduce dramatically the cycle time required for the introduction of new technology. For example, in my area, although undesired emergencies have been a well-known problem on railroads, it still took four or five years for the industry to adopt what are called ABDX and DB60 stabilized brake valves. I think really to some extent the railroad industry is like the United States automotive manufacturers that

used to be accustomed to a 60-month cycle time for new product introduction. The Japanese, of course, set a 48-month cycle time. We all know who gained market share when that situation existed.

Over the past few years, the U.S. manufacturers have brought their new product introduction cycle down to 48 months and I was looking in some automotive trade magazines recently and noted that Ford and General Motors are now bringing that cycle down to 35 months. That is 35 months to design and introduce an entire new car. I guess the question I would ask is how long does it take us to introduce just one component or one change in the industry.

I am afraid that we may have gotten used to some methods and practices that don't make a lot of sense. We have gotten used to some obstacles in the industry that we think are part of the industry and ultimately we have gotten used to a pace of technology change that is just awfully slow for our competitive environment. We need to understand that, certainly outside this industry, technological change is happening faster and faster. Just to give you some perspective on that, photography took 112 years from the discovery of the technology to its implementation as a commercial product. The telephone took 56 years. The radio took 15 years. Television took 12 years, but then it took only six years to develop a working atomic bomb. It took five years for the first transistors, and I think as we all know we can get a MIPS (millions of instructions per second) of computing power in one mass-produced chip and that is going to be obsolete in a matter of months. In my view, we need to be part of the technology revolution or we are in danger of being left behind.

What are some of the key technologies that I am talking about here on the railroads? Here is a short list of those all the way from those that have been introduced but still have problems to those that are coming: 125-ton double-stacks, heavy axle loads, wayside detection, AC locomotives, electronic brakes and so on. There is a lot coming. In my view, we very much need the productivity these innovations represent, and we need to do everything possible to accelerate their introduction. As you will see in a second, almost all this technology has significant implications for our track and bridges.

My third thought is not very innovative but I think we need to keep it constantly in mind. We really need to work better together more than we ever have in the past. I am talking about between the railroads and between departments within railroads. You all may be familiar with what is called a prisoners' dilemma game. This is a classic situation where two prisoners are separated from each other. They are interrogated individually. Each one by implicating their friend can cut a good deal for themselves and shorten their prison time. On the other hand, if each one does what is best for their partner, they both have a chance of getting off scott free. What this game basically evaluates is the conditions under which people act for the mutual benefit versus their own individual benefit.

In short, I think we need to keep this kind of thing in mind and in all cases remember to think about how to create some joint optimal results; both in terms of our work with other railroads and with other departments. You will see as we talk more about technology that cooperation and integration is vital in order to bring this technology into the railroad industry.

Let's just take a minute here and look at some of these new technologies and how they impact track and bridges. The first one that comes to my mind is something that we have all been working on and that is the 125 ton double-stack cars. Not long after these were introduced, we began to experience gauge widening derailments in mild curves of three to five degrees at medium speeds. Investigation over a two-year period has revealed that there is a fundamental difference between double-stacks and conventional cars and it was found that leading trucks on freight cars have more difficulty negotiating curves than do trailing trucks. When the leading truck warps, it can apply gauge spreading forces in mild curves that are sufficient to roll over the low rail.

In conventional cars, this has historically not been a problem because there is usually a trailing truck right behind the leading truck. But on an articulated car, there can be five leading trucks in a row and if the car is heavy enough to apply all the potential gauge spreading force to the top of the low rail, it may roll over.

To solve this from the mechanical side, we are working on reducing the center plate friction, truck warp, and side bearing friction. On a warped truck when the truck doesn't want to steer around curves, this may be because friction in the center plates and side bearings can be greater than the wheel set's ability to steer and rotate the truck without flange contact. Once the flange contacts the high rail, then the truck parallels against the curve causing the wheels to dig into the high rail even more. This applies extreme gauge widening forces enough in some cases to roll over the low rail. These issues are being addressed on the mechanical side and testing will produce the best compromise to minimize this kind of truck warp.

This slide actually shows all the 125-ton issues. On the track side, the issues center around rail lubrication, rail profile with grinding patterns causing two-point contact, wide gauge, and rail restraint. On the Union Pacific, we have worked with the maintenance of way people to develop solutions to minimize the track contribution. If we lube the high rail on a curve, we also now lube the low rail. So if the truck steering forces are lost at least we have some lube on the low rail so the wheel will slip a little rather than roll the rail over. Our rail grinding people have worked diligently to develop patterns that do not produce a two-point contact on the high rail. This helps keep the steering forces intact through the curves so the truck does not warp.

We are also upgrading our track with concrete ties to improve rail restraint and in critical locations we are putting curve blocks in until we can get concrete ties in.

Now, another technology that has been under development for some time is heavy axle loads. By the way, you may not have known this but heavy axle loads originated in the Soviet Union at about the time of Stalin. You can read about the introduction in the Soviet Union in Alexander Solzhenitsyn's *Gulag Archipelago*. In this, he discusses the pernicious influence of the old engineers and the contrast with right-thinking socialist leaders. Speaking as I am to a group of engineers, some of whom may be old engineers, I thought you might appreciate this section from Solzhenitsyn, "What accomplished villains these old engineers were. What diabolical means of sabotage they find. Nikolai Carlovich pretended to be terribly devoted to the development of a new economy and he loved to give advice. One such pernicious piece of advice was to increase the size of freight trains and not worry about heavier axle loads. The secret police exposed Von Matkin and he was shot.

His objective had been to wear out rails and roadbeds, freight cars and locomotives, so as to leave the Republic without railroads in case of foreign military intervention. However, when, not long after the new peoples commissar railroads, Comrade Kagonovich, ordered the average load should be increased, even double and triple them, and for this discovery received the Order of Lenin along with the others of our leaders, the malicious engineers who protested became known as limitors. They raised the outcry that this was too much and would result in the breakdown of the rolling stock and they were rightly shot for their lack of faith in the possibilities of socialist transport." Sometimes you just can't win. Anyway these limitors were pursued for several years in all branches of the economy. "They brandished their formulas and calculations and refused to understand that bridges could respond to the enthusiasm of the personnel. The only thing which at times delayed the arrest of the old engineers was the absence of a new batch to take their place." So all of you old engineers out there, beware. You may be safe only if there is no one behind you.

Fortunately, and we can check with Jolene Molitoris on this, I think that the trend of thinking in the U.S. is clearly that heavy-axle loads are coming and that trend is not likely to be reversed. I hope we won't be shot.

In early June, the International Heavy Haul Conference was held in Omaha. It was obvious at that conference that our industry is moving towards heavy-axle loads. Papers were pre-

sented from all over the world on subjects such as new generation AC locomotives, brake systems, wheel set management, and track dynamics. The AAR recognizes that 286,000 pound cars are a viable technology. The new six-axle AC locomotives that Union Pacific has signed up to buy are going to weigh 420,000 pounds or 70,000 pounds per axle. The whole movement towards heavier axle loads, of course, presents really big challenges for our track and bridge structures.

On our railroad, not all of our routes can take heavy-axle load trains. If what I said is true about needing to earn our cost of capital, however, we do need these heavy-axle load trains and we also need some very innovative solutions to carrying that traffic across our bridges and roadbeds. So any limiters out there or old engineers, you need to put your thinking caps on for this one.

On the mechanical side, as our equipment grows to these heavier loads, the stress and working components such as draft components, brakes, wheels, and bearings increases dramatically. We are already finding that the maintenance and manufacturing practices of the past are not going to be acceptable. For example, couplers with casting veracity fail before it is usually expected. Brake shoes are failing from excessive load and vibration. The AAR rebuild limits for internal bearing components are just not adequate. For example, the cone bore bearing dimension has proved to be extremely critical when bearings are loaded to 286,000 pounds.

There are also some things that can be done to right-of-ways that would help. For example, in undulating territory it could be regraded to minimize the chances of broken knuckles. There are locations now that we are seeing that are almost impossible for engineers to negotiate without placing fatigue building loads on knuckles. Even drag braking techniques seem not to be able to totally eliminate the problem. A roller coaster grade with just a few feet of elevation change can cause enough problems that a look at the cost benefit tradeoffs might be warranted. So that's heavy-axle loads.

Improvements are also coming in wayside detection equipment. This is a slide of an acoustic bearing detector. This identifies bearings that have defective components, but which are not in imminent danger of burn off. What an acoustic detector does is listen to the bearings as they go by. This is a spalled cone and that will cause a noisy bearing. The bearings have a normal noise signature that is recognized by the detector. There is also a speed detector at the same location as the acoustic detector. By listening to the signature and knowing the speed, the detector knows what size of bearing you are working with. If the raceway or the rollers have a spall then abnormal clicks are demodulated from the sound spectrum and they are recorded as an alarm. This technology gives us a chance to get the car to a regular maintenance location or even to a car owner without delaying a train.

We are also using wheel impact detectors. This slide is an overall look at the site. There is a fascinating picture of the site close-up. The out-of-round or wheel impact detector shown in these two slides identify wheels that impact the rail with loads of over 100,000 pounds. This has some influence on bearings, but the greatest benefit may be the effect on track. Cyclic impacts can cause concrete ties to crack and track work to deteriorate with prolonged exposure. The wheel impact detector is located on a special section of track that is instrumented with strain gauges that are able to detect varying vertical loads as the wheels roll over. It seems to work best at speeds of over 40 miles an hour and we use this detector to identify high impact wheels and to change them out before they pound the track work or concrete ties too much.

On the locomotive side we are doing some interesting things as well. This year and next we are going to receive locomotives with a brand new technology from three locomotive builders. These are three pictures of our liquid natural gas locomotives. It's going to be tested on four road and two switch locomotives over the next two years. This technology also has ramifications for track and structures people.

Shown here is a pilot site in Los Angeles. This is literally rocket science. LNG is a cryogenic material at about minus 240 degrees Fahrenheit and it is pressurized at 50 psi. It requires a vacuum insulated storage tank, pipes and cryogenic pumps. The technology is significantly different from anything we are used to in diesel technology. Anyone building these facilities will have to brush up on their cryogenic skills. If this technology takes off, no pun intended, then we will all be learning about how to handle a new material. By the way, it is really very safe. It's fun to make jokes about it, but, in fact, any leaks of this material vaporize immediately. It's not like gas that you have in your home which pools and is very explosive. This stuff will vaporize immediately.

Our maintenance facilities are going to be in need of new ventilation technology. Currently we are planning to defuel units if they have to come into an enclosed shop. But if the facility is properly designed to vent an accidental leak then defueling would not be required which would be a big advantage from an operations standpoint.

Another change in the locomotive side is AC locomotives. In the next year we are going to receive our first locomotives that are going to be upgraded to 6,000 horsepower. These new AC high horsepower units will introduce higher stress to the track structure than we are currently seeing. In addition to the higher axle weights, which I mentioned earlier, the tractive effort is going to be 50 to 80 percent higher than our highest current locomotives. This means fewer units on the train and higher rail contact stresses. These stresses may cause shelling of the wheels and rail.

There is some evidence also that adhesion control on these units is so efficient that the wheels will not slip, but they will pick out little pieces from the rail instead. All the news is not bad. Radial trucks should mitigate some of the flange wear in curves and distributed power could spread the total tractive effort over more length of rail which should help rail creep.

The technology is almost here to make distributed power a reality. Locotrol 3, which is operated by a simple panel, is currently under test on our railroad and when fully implemented will be able to control the train better and stress the cars and track less. When all the power is on the front of the train, the longitudinal loads on just 200 or 300 feet of track are tremendous, sometimes in the order of 0.5 million pounds. A Locotrol may not reduce the total load, but it can spread it out over a lot more track and we are working hard on this system. We expect also this total loading to be applied much more smoothly so that dynamic inputs may be less.

With all the new technologies coming in the locomotive area, we are also gearing up on the freight car side to try and stop the trains more efficiently and quickly. You may be familiar with the term electro pneumatic brake. This uses an electronic means to apply and release the air brakes.

Shown here is one vendor's control unit which attaches on each freight car. This advantage to EP is that all the brakes on the train can be set and released at the same time at least within the limits of speed of light. The result is much smoother train handling and significantly shorter stopping distances. EP will also have a graduated release which means you can also adjust the brake on and off similar to the way that you can on an automobile to control speed. The improvement to running time and train handling seems obvious, but what isn't so obvious is the effect on track. It will be able to run faster and stop more quickly. The concern is if you stop a train quicker, you might have a tendency to push the rail and cause buckling. We are really on the edge of the envelope here and only after we get some experience in testing will we see what the real limits are, but there are some significant issues here for track and bridges as well.

You can see from this brief rundown that a lot of technologies and processes are coming down the road. Almost all this technology has a big impact on our track and bridge structures. As I said earlier, I think it is imperative that we introduce this technology at the quickest possible speed. To do this is going to require a very coordinated effort between departments and

between railroads and personally I think, over the long run anyway, the only thing that is at stake here is our future.

I think our number one strategic problem is going to be earning our cost of capital. I don't see that occurring unless we really sharpen the tools that we are using and improve our asset utilization. We need to learn and study reliability engineering techniques. We need to accelerate the pace of technology change. We also we need to work together.

As you spend time in the conferences, I know you are doing a lot of these things anyway, all I would ask is that you openly share your successes and failures with your suppliers, your customers, your fellow colleagues, and your railroads. Use the information to make logical, smart decisions. Of course, stay away from information that can run afoul of anti-trust laws. This is not a legal opinion. I think exchanges of technical information are fine.

Secondly, if you are not already familiar with the techniques of reliability engineering, you might become so. There are a lot of industries out there, aircraft and automotive for example, which have been using these techniques for years.

Thirdly, think about how to accelerate the pace of change in our industry. We have had a good run, but we are not earning our cost of capital and I think we need to prove that a mature capital intensive industry, something that people still think is a dinosaur can be nimble, flexible, and innovative.

Thank you very much. (Applause)

President Steele: Thank you, Harris, for your innovative ideas of the future and what we are faced with today.

I would like to have John Van Huis to come up and introduce our next guest speaker.

Mr. Van Huis: Thank you, Don. It is my pleasure today to introduce Ms. Jolene Molitoris. Ms. Molitoris was officially sworn in as the administrator of the Federal Railroad Administration by Secretary of Transportation, Federico Pena on September 8, 1993.

As the first woman to head the FRA, Ms. Molitoris brings to the senior post broad rail experience. From 1977 to 1983, she worked for the Ohio Rail Transportation Authority where she began as an assistant liaison officer. She eventually worked up to become deputy director and eventually attained the position of executive director.

From 1983 to 1991, she was the deputy director of the Ohio Department of Transportation. In that role, Ms. Molitoris is credited with developing a proactive and nationally recognized rail program. She has worked on rail issues on both the state and national level. She served for two terms as chairperson of Region One of the National Conference of State Rail Officials and in 1989 and 1992 was the recipient of the MagLev High Speed Rail Association President's Award for outstanding achievement.

Ms. Molitoris holds a B.A. from Catholic University of America and an M.A. from Case Western Reserve and was the first executive director of the Literacy Initiative, a private adult literacy organization. In addition, Ms. Molitoris has taught at the junior high school, high school, and college levels in her native state of Ohio.

After her speech, Ms. Molitoris has asked to go through our training and video room and I would ask that persons responsible for any of the videos in that room please go with her. I would ask that the remainder of the group stay for our next speaker.

It is my pleasure to introduce Ms. Jolene Molitoris. (Applause)

ADDRESS

Jolene Molitoris

Administrator

Federal Railroad Administration

Good morning. It is kind of fun to follow Harris. Harris, you gave me so many wonderful opportunities for segue.

First of all, I can tell you that we are not poor, unhappy, and if we were, we wouldn't be satisfied with that. Second, I can tell you that when I testified in front of the Senate before my confirmation in July, 1993, part of my testimony was focused on my intent to push performance standards as part of the process of rulemaking and for regulation at the FRA. So what that tells me is we need to tell our story. We will be talking about some of the new initiatives of FRA in a few minutes, but the thing I really want to assure you is that although in the administration before mine there was a real serious intent to arm our inspectors, I want all engineers to know that we will not arm our inspectors and that is not our strategy for achieving safety.

John, thanks so much for your introduction, and Mike and Gene Schubel, I really appreciate being here today. I see some familiar faces. Judi Meyerhoeffer, my partner in January of this year when we went to the Pan American Congress with a delegation of American companies who went with me to let people in South America know that the best manufacturers and operators and maintainers of railroads in the world are in the United States of North America. We were successful because we went as a team to talk about what we can do together.

I know from many of the partners with me down there that contracts have come into being as soon as three months after our trip. It was very exciting to see. In fact, one of the things that I remember is during the kick off speech of the Pan American Congress which I gave all in Spanish, they thought I could speak it, they don't know I can only read it well, I introduced all of our delegation and everybody stood up. They said afterwards they felt like the Olympic team because they were getting all sorts of applause and cheers.

Being together as a team with the railroad industry is really a tremendous opportunity for us all. One of the slides that Harris used was cooperating together. I would add to that, communicate together. Because I find every day that what we have in front of us are really people problems more than technical problems.

We will be talking today a little bit about the enormous quantum leaps that our industry is taking in our technology development. The future is enormously bright. Being the Federal Railroad Administrator is always an honor and a privilege, but I have to tell you that being Administrator with a President and a Secretary who not only know that the FRA is on the 8th floor, but spend time there themselves and, not just talk about railroads as being a crucial part of the national transportation system, but also invest important budget dollars in a time of cutbacks in the industry that they think is crucial for the economy of the 21st century.

Some of you I saw in Pittsburgh at the Superintendents meetings. Let me just introduce some of my partners from the FRA. Gordon Davids is from our bridge department. Fred Dennen is deputy regional director here in Chicago. Rich McCord is the regional director. We have an enormously fine leadership team here in Chicago. I always say to our FRA team members, don't be shy. Meet everybody you can. Because one of the things we are learning at the FRA is that we can't do our job right if we do it alone. We can't design the best kind of regulations and rules in a room with the door closed. That is why that door is open. Part of the administration focus is on the whole issue of being proactive and inclusive.

What we are learning about regulations and safety is that first of all, reaching the kind of safety goals that we have we cannot do by regulation alone. Regulation is one tool in a whole

menu of ways to reach safety. Let me say before I go on that I have just enormous personal respect for the over 100 years of commitment these organizations have had with regard to safety. You are the people who can teach us the most because what we know is if we go out and reach out to the people doing the work who are closest to the issues, we will gain great wisdom.

As I mentioned to you, the President and the Secretary have been extremely supportive of what we are doing at the FRA and what you as an industry are doing. Many of your CEOs have sat personally with the Secretary. With the budget from last year and a five-year budget freeze we must understand that we are in a zero sum gain. If the FRA and rail programs gain more funds, it means that they came out of something else. That is just the way it is. And when the Secretary recommends to the President that programs at the FRA and rail investments be increased, it means that he has made a decision for rail.

As a matter of fact, next week will be the first secretarial rail summit in the history of the FRA. This summit is part of an evolution because the Secretary understands he needs to talk to you face to face and I understood that the minute I walked in the door. That's why over the past month we have held 18 administrators round tables. An administrators round table is a brown bag lunch where leaders from across the industry — labor, management, suppliers, customers, and shippers come together with me in a not very glamorous conference room and talk turkey about what is really going on. The opportunity to hear that in first person has been very exciting for me. It has been a wonderful learning experience and from what I hear from the people who have attended, it has been extremely useful. In fact, each of these administrators round tables has resulted in actions that have been very important, I believe, for the way we are reengineering the FRA.

As you know, the President has given us a great challenge. He has said it simply. "We need to have a government that works better and costs less." The National Performance Review which was presented by Vice President Gore just about a year ago has made tremendous achievements in reaching those goals. Just yesterday I was in Oklahoma City giving out little hammers and those hammers are the symbol for breaking through red tape and getting rid of antiquated overburdensome regulations. For example, the Small Business Administration has reduced its loan application from 100 pages to one page. The Office of Personnel has discarded a manual that, I can't believe it and I am sure you can't believe it, was 10,000 pages long. Incredible.

When we hear Harris talking about cycle time, that is really what we are about, too. I think if you look at your own industry, you will see that the FRA as part of that industry is taking the kind of quantum leaps that you have shown to work and incorporating it into our own business.

For example, I have a few brochures from when the Vice President talked about customer service on the White House lawn last week, he talked about FRA, because our safety office and our safety program is being totally re-engineered. It's an extremely exciting time because we have learned that there is a way to do business better and there is a way to do business faster.

This is a brochure that says, "FRA safety programs, we are committed to serving our customers" and I am looking at all of you who are our customers. It talks about what we do, who our customers are, our commitment and challenge, and then there is a list of what our commitments are and when we are going to do them. I want to read one of them because I think it probably has some meaning for you. "Investigate inspection complaints from railroads within ten working days." That is our commitment. No more black holes at the FRA. People said they used to send things in and figure that it went to a black hole.

We have an enormously committed professional staff. They have been very hampered by a lack of attention from administrations in the past and by a lack of technology and by a lack of resources. The Secretary has committed to us to invest in our people so that we can

truly serve our customers better. You know how safe this industry is. We have an enormously admirable record of increasing safety in our industry and you have so much to do with that. The people who maintain our bridges, maintain our track, and protect the safety of individuals who work on the railroad have a lot to do with that.

You take your job very seriously and so do we. Unfortunately, railroad workers doing critical work are still dying. Our goal is zero accidents and zero fatalities. Some people may say that is impossible. But how could we have a lesser goal? I think the challenge of that goal is something that we can move closer and closer to as we work together.

I have a few comments about the new FRA. As I said, we recognize that we cannot do this job alone and the open-door policy is one that is extremely important to the kind of success that we are trying to reach. The round tables have told me a lot. They have said that if I listen and if we are together with the group of people who are committed to a goal that is mutually effective for all new ideas, barriers get broken down and you make enormous progress just by getting the people together and talking about what concerns them.

So far, the 18 round tables have included things like signals and train control, research and development, track and structures, and innovative financing. Out of each of these, important changes in the FRA occurred. For example, our training program is being redesigned. One of the things that we learned is that we need to get everybody at the table to come up with something that works.

For example, in terms of locomotive inspections, we have begun a series of training videos using you. We went to Baltimore with CSX and the Brotherhood of Locomotive Engineers and our inspectors and we did a video of a locomotive inspection. Then before it was edited, we went back step by step, frame by frame, with everybody at the table and went through that video to find out about FRA's list of inspection criteria. Is it the right list? Is it too short? Is it too long? How long does it really take to do it right? We found out a lot and we are changing that process based on the input of management, labor, and all of us working together. What that means is both railroads and workers will understand what is expected and will understand what the FRA inspector is looking for. Throughout the next month you will see opportunities on the railroads for management, labor, and FRA to go out and look at tracks together and find out how it is really done and what the FRA inspectors are doing.

I think that you all know consistency was something that we lacked throughout our regions. The consistency issue is something that was discussed with me before I even walked in the door. Part of what we must do to reengineer our inspection program and gain credibility with you and gain safety with you is to assure consistency and fairness in the interpretation and application of our regulations throughout our eight regions. Bruce Fine, who is our new associate administrator for safety, is doing just that. They are doing resolution committees which include inspectors instead of Washington making up the rules and then sending them down to the field and to the railroads. This is going to be a mutual opportunity to get the best, most workable, effective regulations and inspection criteria that we can.

Let's talk a little bit about rule making. Rule making was something that Harris mentioned and I think we have made a lot of progress in that area. What you are going to see is an effort on our part to use the negotiated rule making process as a way to really change what is often a hostile environment in the traditional rule making process. In the traditional rule making process, staff puts together to the best level of their information a rule and then publishes an advance notice of the proposed rule making. Then people respond and there are hearings and people sit across tables and old scripts about hostility and about negotiations really come into play.

If you look at a lot of the hearing records over the past five or ten years, what you will see is a lot of the same things because people are playing out their scripts and people are saying the party line, whether it's management or labor. You don't get the richness of opportunity to talk about new ideas that are going to work better.

We have made that our first effort as a negotiated rule making. We are hopeful that we can announce the team for the negotiated rule making at the summit on September 30th. That is on trackside worker safety. Twenty-one individuals have died over the last five years. That dying is unnecessary and can stop. Together we can change those numbers and change that rate of accident. The negotiated rule making process is pretty new in the Federal government and a lot of people say that it's going to take longer than the traditional way of doing things. I am optimistic about the fact that a small team working hard who really wants to get business done quickly is going to prove the nay sayers wrong.

But while we are working on the negotiated rule making, we have done other things about trackside worker safety. For example, when we held the meeting to talk about this negotiated ruling, Stan McLaughlin was there, as well as Mac Fleming from the Brotherhood of Maintenance-of-Way Employees, and they were part of the thinking team that contributed to a plan of action. This plan of action included distributing FRA's five-year report detailing recent fatalities. We rewrote that report so it was more user friendly and in fact made sense. Because of the way it was before, I don't know if you ever read it, but I certainly couldn't understand it.

We also agreed to have meetings on properties to talk about existing safety rules, how they could be better put together, and made more user friendly. That first meeting was held in June and today there have been more than 4,000 meetings on properties around this country on the issue of rules and safety activities around trackside worker safety.

Third, we agreed to increase the level of safety training in this area.

Fourth, we agreed to identify areas where new rules may be needed.

Finally, fifth, we decided to pursue the negotiated rule making process.

Another example of cooperation is the bridge worker safety rule which actually was adopted in 1992 and although it didn't use the negotiated rule making process per se, it was an example of cooperative efforts that ended up with a good rule. We issued an amendment recently to remove some of the constraints that have been a little unwieldy and your record of impressive safety shows that your decision and professionalism is working.

In addition, work is done differently on bridges now that positive fall protection is used consistently. A few years ago, harnesses and life lines were practically unknown on many railroads. This is a case where we relied on advice from safety experts in rail labor and management and the negotiated rule making reflected that.

I would like to make one particular point and that is that it has come to my attention that this bridge worker safety rule does not just apply to people in the bridge and building department. A lot of times people don't realize that. It applies to anybody who is working on a bridge. That is whether they are bridge maintainers or track workers or signalmen or electricians or chief engineers. Our inspectors tell me that these workers are not always in compliance with the rule. But they should be. We are working to ensure that because they can fall just as far as anyone else from a bridge.

Bridge integrity is something that people are talking about a lot. Two days from now will be a sad memory for me and for many of us because on the 22nd of September, 1993, the Mobile tragedy occurred and 41 people died. It was an awesome sight that will never leave my memory. This was nothing to do with bridge integrity but all the pictures that everybody saw were of the train and the bridge. There were hardly any pictures of the barge that hit the bridge.

The Coast Guard and the FRA are working very hard to implement new ways of impacting the way barge drivers do their business. The Coast Guard has implemented new rules and regulations and we are working and have evaluated new technology for detection of intrusion and fouling and other problems on bridges. In fact, we will be making an investment on a high risk corridor. We have two good technology pieces that we are looking at to see what might be the best, low cost way of notifying railroad employees that something is wrong on a bridge.

FRA inspectors will continue to observe and monitor bridge management and inspection practices on all railroads. We will document those good and bad safety situations and that will serve to help us continually review the policy on bridge integrity. Our survey has told us that we do not need a rule making on this issue but, in fact, have issued a policy instead. The statement will essentially be an open docket, not a regulation, so that it can be revised as necessary. The policy includes an invitation for comments at any time from any of you who might have a good idea for us.

With regard to track standards, there have been 12 years without a major revision and we are now considering whether and how we would amend them. Last year we had several craft safety workshops around the country and got a lot of input from you. A notice of proposed rule making will be coming out soon and it will show evidence of the discussions that we had with you and the results of these 12 years of research and studies that we have done.

I don't know what your policies, your company's policies, and your organization's policies are for following the Federal Register, but we are encouraging everyone to stay in communication with our office because there is a lot of important information. For example, just last Thursday we had an announcement on a train signal and control demonstration project and money that we expect to be passed before the end of this month in our appropriation. We announced it in the Federal Register early because we believe in that increased cycle or improved cycle time theory that Harris was talking about. In other words, when Congress passes our research and development money on October 1, we don't want to wait until June 1 of the next year to get it into the marketplace and to get money out there so that you can move this research and development area further along. So there will be several announcements about the money that will be invested. That money has increased and the reason for that is because the President and the Secretary believe that if we can provide incentives to suppliers in partnership with companies who are doing good work that this industry of ours can move to new heights in terms of its safety record.

Our rail map will look very different in about three years. Anybody who is paying attention knows that some people call it an evolution, but I have to say I think it's a revolution because evolution sort of gives you the idea that there is a lot of time involved. I think what we see are potential mergers, quantum leaps in the growth of intermodal, new reauthorization of ISTEA, national transportation systems, and clean air. Railroads provide an opportunity for places like California to respond to their clean air responsibility and their clean air challenges.

I think that this industry is in a revolution. I think it's an exciting time to be in this business because people are recognizing what you have known all these years. This business of ours is the best, safest, most environmentally friendly, efficient mode of transportation to move products and people in the world. In fact, our industry is the envy of the world because of the kind of partnership that you have forged at your companies.

We want to be a facilitator and a partner with you. For those of you who think that the best relationship to have with the government is none at all, I am asking you to re-think that because I believe we have shown in the past year that together we can even make achievements far greater than what we, individually, can do alone. The Track and Signal Report to Congress in July was a perfect example of that. We said in that report that the cost benefit analysis on this issue does not warrant a universal mandate. However, we set out a timetable. We set out a course of action that we felt was reasonable. In fact, Union Pacific and Burlington Northern not only responded theoretically, they responded with a demonstration project laying down a test bed of over 800 miles of high tech train separation demonstration. We are excited about that.

We have been hearing from other railroads that the same kind of initiatives from the private sector is being facilitated through our work together. So I am excited about what you are achieving.

I am hopeful that you will work with us and give us opportunities to support what you are doing. I am hopeful that you will begin or increase your communication with, not only FRA in Washington, but your regional offices as well because these are the people on the ground, our force of inspectors and regional directors and specialists who work with you every day and they are the best in the world. We are committed to increasing their training so that they can keep up with the wonderful, exciting, and sometimes awesome technological revolution that is going on.

I appreciate this time to be with you. I very much look forward to seeing your training and your demonstration area. We have a few minutes so if some of you would like to ask questions, I would be happy to dialogue with you.

I hope that you will stay in touch and communicate with us. Let us know how we can serve you better and how we can do our jobs better. Thank you so much. (Applause)

Mr. Van Huis: Jolene, thank you and certainly the organizations appreciate your comments that you regard our organizations as very viable and hopefully we can exchange a lot of information in the future. Thank you.

Mr. Koff: Well, it seems appropriate that our next subject is on training. If you remember, our theme for this year's conferences is "Training for the 1990s," and we are very pleased to have Ed Butt from our Burlington Northern group here.

Ed serves as director technical training for Burlington Northern. Before retiring from the United States Air Force in 1988, Ed helped manage a number of U.S. space projects. In his last assignment, he served as director of plans and operations for the United States Space Center, an organization that has responsibility for launching and operating all United States military space crafts.

In 1988, Ed joined the Burlington Northern Railroad as a director in their research and development department. In 1992 he was assigned to director of technical training in Overland Park, Kansas. He has an undergraduate degree in aerospace engineering and has a Master's in business administration and public administration.

Ed has taught mathematics and physics at the University of Evansville. He has published numerous papers on space sciences and in May of this year he was asked to deliver a paper to the National Academy of Science in Washington, DC, on the application of space technology to the railroad industry.

He is very well qualified to be with us today and I thank him for coming. Please welcome Edward Butt. (Applause)

TRAINING

Ed Butt

Director Technical Training Burlington Northern

Thank you very much, Ken. As I look around the room I know you are all anxious for a break. When I look across a room of students, they have that look of a glassy eyed stare that you currently have so I will make my comments as short as possible.

In the last 15 years, the railroad industry has substantially restructured itself. That restructuring has taken the form primarily I think, although not entirely, by shrinking our-

selves. Harris alluded to that in his comments earlier. We have reduced the amount of track. We have reduced the number of rolling stock that we have. We have reduced substantially the number of people. At the same time, the productivity has increased tremendously. We have seen many fold increases in revenue ton miles in the railroad industry. It should be noted, however, that the tremendous trend in productivity increase that occurred throughout the 1980s really leveled off a couple years ago. There are two initiatives I think, inarguably, the entire railroad industry is pursuing in order to see those productivity gains increase over the next decade and on into the future.

One of those is technology. I would suspect that virtually everyone who speaks at this conference will be speaking to one extent or another about technology — about new technology and about the growth of technology in the railroad industry. Technology represents investment that we must make in things in order for our industry to be more competitive and for our productivity to continue to increase. But there is another investment that has to be made that goes hand and glove with the technological improvements that we are going to make, and indeed the improvement in productivity in our industry, that is invest in our people. If we don't invest in our people at the same rate that we invest in things, we will not be successful.

That is what it's all about. It's an investment in people. There is a very exciting program or a series of programs that are occurring in the railroad industry that I am going to show a video about in just a moment.

The Burlington Northern began a trend back in 1988 when we located our training center on the campus of a community college. That was a very dramatic thing for us, I might add, and for the community college as well. It was an experiment that no one was certain how it would turn out. It has turned out to be a tremendously powerful relationship and it has created a training tool that I think is unparalleled in the industry.

The Union Pacific just signed an agreement with Salt Lake City Community College and is building a beautiful and tremendous training center on that campus that should be opening up sometime next year.

CSX has worked with Florida State Community College in Jacksonville and has discussed a similar type of training center in association with that academic institution.

The Norfolk Southern is also pursuing this and Conrail, I understand, is also in conversation with academic institutions.

There is an opportunity for the railroad industry and for academia to come together and to create the training tool that is really going to be necessary for us to be successful in the future.

With that, I have a very short video that I would like to show you that really reflects and represents that relationship that we have.

The partnership with an academic institution is one that we had not foreseen would be as powerful as it is. One of the major products that has come out of that are two degree programs that simply did not exist before. You can get degrees in transportation in virtually every other form of transportation in this country except for railroading. You can get a degree in railroading in Europe; you can get a degree in railroading in Asia; but the first time you could get a degree in railroading in this country really came with these two-year associate degree programs. We are really hopeful that we can extend those into a four-year regime some time in the near future.

What is the goal of training? The goal of training is one of change. Specifically to change the behavior of students so that their on-the-job performance matches whatever the corporate goals are. In technical training, we break that down into a lot of fine detail, but I think it's so important to reflect that when we talk about training, we talk about change, and we are talking about the change behavior. When we talk about training, we are talking about on-the-job performance. There are many different kinds of training, but if your training is not targeted at performance on the job, it is probably not going to be successful.

We have some beliefs about training that I think are agreed to pretty much across the industry. First of those beliefs is that training is an investment. It is not just an expense. What happens if you treat training as just an expense? What will you do about it? You tend to shrink it, make it smaller, and make it go away and that's very easy to do.

Training is discretionary and always in the short run. Training is only nondiscretionary in the long haul. Training is an investment in our people to the extent that we can teach the right subjects. Sometimes this is rather difficult for us to discover as trainers because it is our customers and our customer departments that tell us what the right subjects are, to the extent that we can discover the right subjects and train them so our students learn what we teach. The only way we can know that is by continuous and constant measurement of progress performance during the training process itself.

At the training center, we measure almost continuously whether or not an individual is getting the subjects to the extent that our students learn what we teach and to the extent that our students apply what they learn on the job. That's called transfer of training and it is the responsibility of management, not a responsibility of training. Then there is a substantial return on the investment.

We have a number of measures to date. Those returns can be quite large and that's one of the reasons that we have seen a tremendous growth in our training center. This chart indicates the different areas within the operating department. This we do after training.

If you look down the lower right-hand corner, you see maintenance-of-way training. We do all training on track. That training program focuses right now on track welding and on roadmasters courses but it is also expanding to include different areas of track work.

A substantial program that is growing and increasing is B&B. Many of those courses are taught by the college in terms of blueprint layout, air conditioning, facility construction techniques, et cetera. The bridge program is growing and expanding.

Union Pacific has a great bridge training program. We are trying to take on some of those training techniques that they are using.

I did want to focus for just a minute on our work equipment training area which has grown over the last couple of years by leaps and bounds. In fact, we didn't have much of a training program a couple of years ago. Today, I think we have one of the finest in the industry.

This year, in addition to the other work equipment training programs that we have, we added two new courses. One of those is in crane training. We have a crane training simulator which is the training center and that crane simulator is used for teaching both operations and maintenance, at least the operations side of it. We want our students to experience crane operations. It is not enough that you just give them a presentation or briefing. You are not going to be successful. So we have a crane on the property and we actually go out and operate this crane and ensure that either existing crane operators clearly understand how to perform successfully or new crane operators get that important first experience in a controlled environment that allows them to be successful out on line.

A second program that we have in the work equipment area that is really exciting to us is an experiment that we tried and it turned out to be quite successful and that is a mobile training van. It is virtually impossible, as you know, to train work crews. Because of the bed and bunk process you are never sure who is going to operate what equipment and when. So you virtually have to train everyone on every piece of equipment that you have. That is an exaggeration, of course, but you have to train an awful lot of people you wouldn't be training otherwise. If we were to do it in the traditional way in the formal sense, it would also be quite expensive.

We now have a mobile van that can pull right up to the work site. Before a gang goes to work, it spends a day or two going through, in detail, our safety policy and procedures and/or general orientation. We can talk about how to inspect that equipment and operate it successfully. It has turned out to be a tremendous asset in the work equipment department.

We will see that program expand into the future. As of the end of August, we have trained over 900 students out in the field this year. By now it is probably well up over 1,000 and that van will operate until the snow flies. Even then, I suppose we have operators who we can go down south and operate some more.

I really didn't come to talk about the things or the curriculum that we have, but what I really want to talk about for a few minutes today is about training as a process and the importance of knowing and understanding that process for successful training.

I am not going to discuss this detailed chart other than to say that the most important part of the process of training is a good need analysis. That's where all the training starts. It is necessary that we understand very clearly what our objectives are in training or we are not going to have targeted successful programs. We need to know very clearly what our objectives and priorities are so that we can be successful in putting those training programs together.

We must realize we are dealing with adult students. If our training program doesn't recognize that our students are adults and recognize that difference in training adults versus children, we are not going to be successful. So we must focus on that process. I wish I had time to make a presentation on what the differences are as I think you would find them interesting, but if your training program doesn't recognize the differences, it is not going to be successful.

We need to focus on learning versus training. We talk about training and we use that verb almost exclusively, but the real bottom line is not training. The bottom line is learning. Students will not learn unless they are put into an environment that allows them to be successful. Training is not going to be successful unless learning actually takes place. Training programs that focus on the presentation and focus on the mechanics of training and focus on the material to the exclusion of what is happening inside the heads of the students is not going to be successful training and that has to be addressed very carefully in the design process of the training programs.

There are three learning demands, and I think most of you know this, but perhaps not as formally as these three words. First of all, in order for training to be successful, the students' attitude must be positive. If you don't have positive attitude, and you enter into a training program, you simply won't learn and learning will not take place.

Secondly, in order for you to be successful as an employee out on the railroad, you have to have some base of knowledge from which to operate. We don't want to overdo it. Knowledge-based training is something that we focused on in the past and that's what most of the schools and universities in the country focus on. It's not what we are after, but there does have to be some general knowledge base in order for student to be successful. What we are really after are skills. We want our employees and ourselves to be successful in a skillful way. We want to be able to do things, not just know things and be able to say things, we want to be able to accomplish things.

Training really at the bottom line needs to be focused on skills as a measurement of our ability to do something. We must have a positive attitude in order to get there. We must have a certain base of knowledge before we can be successful at acquiring skills. We want our employees to be problem solvers. The idea of a human being as a replacement for a machine or as a type of machine has been very prevalent in our industry and, in fact, in our society. The rules come to mind when we think about rigid checklists of things that we must do in order to be successful. We want to get away from that. That's not the way we are going to increase productivity substantially and it is not the way we are going to be successful.

We really want to cause our people to be able to approach either operations or maintenance in a way that allows them to view a problem that needs to be solved and use their training and their background and technology that is available to them to be able to solve those problems.

We also want to think of training not as a single event that occurs one time and that's very typical of most training. We think of it as something that we do to somebody and occurs

over a finite period of time. Training is really a learning process that occurs over an entire career.

What this chart shows is that in the old learning curve I have calm and straight there, but I hope to show it in a new way. Don't think of it as learning as a single event, but as development over the entire career. If you look at the time bar down at the bottom and you look at the extent of the curve, that would be over an entire career of a single individual. Now that is an idealized curve and, yes, there are ups and downs on that curve as we change jobs and go on to other work. Nevertheless, when we think of training as lasting over a lifetime, as we think of development and performance as increasing over a lifetime, I think we will be a lot more successful.

Where is training most effective? At what point in an individual's career is training most effective? It's at the point down at the bottom when the curve is flat. That is the time when an individual coming into the railroad industry or coming from a craft is most in need of a training event. That is the time when training or learning is frustrating to the individual as he is trying to acquire new skills and knowledge. It is most frustrating to the trainer who is trying to impart those skills and knowledge to the individuals. That's one of the places where we typically ignore training. We typically don't do training until later on when we are up on the steep part of the curve.

We are doing some journeyman training that can also be quite effective, but it is most effective when we do training early on initially when we get new individuals who come on board the property or who are changing jobs and are seeking skills in a new field.

You will see in our training center that we are focusing more and more on new hire training and on apprentice training, but we also have a substantial amount of journeyman training that goes on.

Finally, let me say that it is a learning team that we need to focus on and we need to talk about. At the top of the learning team is management. The training responsibility does not really reside with trainers. It couldn't possibly reside with trainers. It is really management's responsibility to ensure that employees have the skills and the knowledge to do the job. It is really your responsibility to ensure that the people who work for you know how to accomplish their jobs.

It is also your responsibility to see that any new skills that they might acquire are applied on the job. There has to be systems and processes in place at the job site to ensure that the transfer of training takes place.

The trainers have the responsibility for understanding what the training need and training jobs are and putting programs together that are going to be successful. The trainers are also responsible for keeping up with new technology in the training field and ensuring that the training event is as productive as it can possibly be.

Finally, on the learning team one member that we typically leave out is the student. It is the trainee's responsibility for making sure that they participate in the training events, that they maximize their opportunities in the training events, that they do their work, and if they don't, they are not going to be successful. They also have a responsibility as part of that team to apply whatever new skills and knowledge that they have out on the job. I mentioned earlier the idea of attitude. Without proper attitude, that is not likely to take place.

Those are a few thoughts that I wanted to share with you on training. The last thing I would point out to you is that there is a real concern within our organizations, and I am sure within your railroads about the cost of training. There is a price that is to be paid and it is measured in dollars and cents for training and the training event. I would simply point out that if you are lacking any precise measure of training return on investment, we do have some measures and they are getting better all the time. If you think training is expensive, just try ignorance because the cost of nonconformance and the cost of ignorance is just staggering. It's really staggering in our industry. We are just beginning to catch on to this idea that if we

invest in our people, if we train our people, particularly early on when they first come on the job, that they can take that throughout their entire career and their productivity will come up very rapidly. It has just a tremendous payoff at the bottom line.

Thank you all very much for giving me this opportunity to address you. If you have any questions or comments, I would be happy to take them. Otherwise, have a good conference. (Applause)

Mr. Koff: We are now through with our first session. B&B will reconvene in the Cotillion Room in 10 minutes. Roadmasters will meet back here. (Recess)

BRIDGE AND BUILDING SESSION

**Tuesday Morning
September 20, 1994**

President Steele: Ladies and gentlemen, I welcome you to the second session of the B&B conference. There are a couple things I would like to bring up right now. Please fill out the evaluation cards. It means so much to us as it tells us where we need to go and what we need to do. Also take a look at our next year's subjects. I have talked to a few people and they have already volunteered to assist. But you are the ones who make these conferences strong and worthwhile. So fill them out and help us out because it is your Association.

At this time, I would like to turn the podium over to John Van Huis for the next presenter.

Mr. Van Huis: Thank you, Don. Our first presentation this morning is on stress laminated bridges and will be given by Willie Benton of the Norfolk Southern. Willie is a graduate of the University of South Carolina and a licensed professional engineer. After graduation, Willie went to work for the Southern Railway as a management trainee and then as a track supervisor.

He was transferred to the B&B department in 1974 as an assistant engineer. Willie has held several jobs in the bridge department since then and is presently engineer structures for the Norfolk Southern.

STRESS LAMINATED BRIDGES

Willie Benton

**Engineer Structures
Norfolk Southern**

Thank you, John. I am very proud to be here and have an opportunity to talk about stress laminated bridges. I would like to thank Mike Bradley for giving me this opportunity. I also need to thank Don McCammon of HNTB and the CN North America for furnishing some of the slides that you are going to be seeing today.

What is a stress laminated bridge? Some of you here may already have some experience in stress laminated construction. It is, however, fairly new to the railroad industry. It would be more accurate to describe it as a stress laminated deck system, a series of nominally two-inch thick timbers that are stacked together to the desired width and held together with steel tensioning rods and inserted through predrilled holes and planks. The individual units act together as a single unit of much greater strength.

The depth of the planks and the tension rods are designed for the specific span length being used. Again, this is a fairly new concept in the rail industry but has been in existence in the highway industry for several years.

Like many of you, I am a member of the AREA and serve on committee seven, which is the timber and structures committee. In 1990, I began studying railway applications for stress laminated deck type structures. I am working presently on a user-friendly design table and recommended practices for railway loadings.

Why use stress laminated construction? The environment. Today the environment is in the forefront of almost everyone's thinking.

Timber for stress decks may be cut from smaller trees and fully treated yielding a longer life structure resulting in the use of fewer trees. We all know timber is a renewable resource.

Economics. We all have a responsibility to get the most for our company's money. Smaller timber size used in stress deck and construction is less expensive and more readily available. Again, more complete treatment means longer life and less maintenance.

Ease of construction. Stress decks can be built with large gangs and large equipment or can be easily assembled using a small gang with lighter equipment. The Canadian National built the first stress laminated railway bridge in North America on their Gladstone subdivision near Winnipeg. They replaced an existing timber open deck structure. The new spans were 14 feet wide and nominally 12 inches deep and approximately 13 feet 6 inches long. They were built on new timber pile bents and concrete caps.

The following slides carry us through the construction of this project. It was really an interesting project. They did a great job and if I had all day I could tell you everything they learned about stress laminated construction, but we will try to go through some of it here. If you have any questions, I will try to answer them afterwards.

The timbers were predrilled and delivered to the site for fabrication. Here you see the planks being threaded onto the stressing rods. With the timbers threaded into the rods, a steel channel and bearing plate were added to the outside to evenly distribute the stress on the rods.

You see them putting the channel in place there. This is something they don't use on highway construction, but we felt was necessary in railway construction to have more uniform distribution. Notice the channels and the steel bearing plates sitting up on top of the timbers that have been put together.

In this shot you see the planks stacked together over the rods and the steel channel that we put on. This is just a shot of the pump they used. It's no big deal. It is fairly small and easy to handle. It is easy to acquire. The pump used for stressing the rods was multiported allowing stressing of several rods at one time.

There are the divisions in the pump where they take it off and the different jacks being used. Here we see the tracks used to tension the rods. The rods are actually tensioned three times in the construction process. There is the initial stressing when they are placed and then approximately 30 days later they will be stressed again to guarantee that they have retained all the tension they need. Preassembled and tensioned panels are then set.

The timbers are pulled together tightly with the channels and the bearing plates and then they are set on the new timber bents with steel caps. Waterproofing the deck is something that the CN felt they needed to do just to assure that they didn't get any water intrusion into the timber. My personal opinion is that the planks are so tightly stressed together that you are not going to get any anyway. Waterproofing membrane is really an option that you have to consider on a location by location basis.

The ballast curbs are being placed. I neglected to mention that those are steel plates across the joints. With all the ballast in place, they come in with a new track panel that they are going to set in.

In highway construction, they don't have the steel channel that we have opted for in railways. They just have the bearing plate.

Stress laminated timber is really new in the railroad industry, but it has a lot of applications. Sometimes we are slow to accept new things, but this, I think, is a very good change in technology and has a lot of good applications.

Thank you very much. (Applause)

Mr. Van Huis: Thank you, Willie. Our next feature is treatment of railroad wastewaters by Steve McNaughton of the Union Pacific.

Steve has 13 years of management experience in the railroad industry. He began his career with the Missouri Pacific as a management trainee, progressed through the engineering department, and was involved with the maintenance, design and construction activities. He is

a licensed professional engineer, a member of the American Society of Civil Engineers and AREA. Steve is manager of environmental field operations for the Union Pacific in Omaha.

TREATMENT OF RAILROAD WASTEWATERS

Steve McNaughton

**Manager Environmental Field Operations
Union Pacific Railroad**

Thank you, John, and thank you all for having me here today to speak with you.

As John said, I work as manager environmental field operations with the Union Pacific. In this position one of my responsibilities is to manage the operation, maintenance and upgrade of the railroad's wastewater treatment plants on my particular territory.

This first slide somewhat reflects the way that railroads and other industries handled their wastewaters prior to the 1960s. Prior to the 1960s, many facilities used the surrounding streams and lakes as their discharge points and provided very little in the way of wastewater treatment. In the 1960s and 1970s, it became more apparent that water being discharged from railroad facilities had the potential to pollute the rivers, streams, and ground water near those facilities.

In 1972, the US Government Environmental Protection Agency enacted the Clean Water Act. This regulation set up rules and standards for the way industries treat and discharge their wastewaters. The law said that industries with wastewater discharge would be required to have permits from the regulatory agency that authorized that discharge. It would also put restrictions on the allowable concentrations of certain contaminants in the facility's permit of discharge. These regulations created a need to treat the water to meet the discharge limits.

This leads to my topic of discussion today — the treatment of railroad wastewater. Before we look at treatment units, I would like to quickly discuss different types of wastewaters that are generated in the railroad industry. I have listed here a number of types. This by no means is a complete list, but these are some of the more common ones. They include:

1. Spilled petroleum at fueling and maintenance facilities.
2. Wash water from locomotive wash facilities.
3. Shop floor washing.
4. Parts cleaners.
5. Freight car rinsing.
6. Washing of any other type of equipment that we have.
7. Contaminated storm water which is collected at an outdoor maintenance and fueling location.
8. Waste from metal plating operations.
9. Radiator rust inhibitors and coolants that are dumped from the locomotives at the maintenance facilities.

These different wastewaters have a wide variety of contaminants within them. Contaminants including oil and grease which are, by far, the biggest wastewater concern in the rail industry. Also, the water can contain various metals such as lead, copper, zinc, nickel and chromium, surfactants which are soaps and cleaning agents, phenols, chemical oxygen

demand, biological oxygen demand, and total suspended solids. The presence of any of these in the water, if it's discharged, has an adverse effect on habitat, fish, wildlife, bacteria, water and so forth.

I don't know if you can see a contrast in there or not, the water is pretty murky. It has a quantity of oil on the top of them. This one has just a little, this one has about an inch, and this one is just about completely oil. I also put out a sample of treated water. This would be the same as one of these after it has gone through our treatment systems. That's what our goal is, to make that murky water look like this so that we can discharge it back to the surface. This particular sample gives the appearance of being mostly oil. Actually the sample is about 80 percent water. It has a consistency very similar to pudding. It is very thick and if I were to open up the jar, not only would we be overcome by petroleum odor, but you could reach in with a spoon and spoon it out just like a gel. Even though it is nearly 80 percent water, if I let that sit there for about a month or two and we came back it would look just about identical to that. There would be very little separation. It is called an oil water emulsion. Actually all of these samples are oil water emulsions to one extent or the other. That's why the cloudiness and color in the water.

These emulsions occur mainly as a result of two things: mechanical agitation from pumping and by the introduction of cleaning agents in the wastewater. The cleaning agents are designed to put the oils and other contaminants into solutions so that they can be washed off the equipment or off the floor if someone is cleaning up a spill on the floor.

Getting the contaminants back out of the water is the problem we are faced with. This slide is a representation of minute droplets of oil that are dispersed within the water in these emulsions. The oil droplets are charged particles and are each surrounded by an ionic field. This causes the particles to repel each other and prevents them from coming together and forming larger droplets. The larger the droplet, the faster it rises to the surface. So having all of the negative charges on the minuscule oil droplets keeps them from coming together and rising.

Let's look at the flow of a typical wastewater treatment plant. I will get into some of the specifics of some of the components. As you can see on the slide, we have influent wastewater at the top. The first step that we use would be grit removal, some sort of solids removal, and then oil/water separation, pH adjustment. Then if needed, we could go with some sort of enhanced treatment. Usually this involves the injection of some form of chemicals that help to react with the emulsified oil and help it to separate out.

At the bottom, of course, is our discharge to a stream or some other surface water or possibly to a city or publicly-owned treatment works.

First, as I said, is a solids removal. The use of traction sand in the locomotives causes high amounts of sand and grit to be included in the wastewater stream. The ideal solution to these solids is to not let them get into the wastewater treatment plant in the first place; that is to shovel them off with the drip pans and to remove them from inspection pits before they go down the drains. I know that's not always done and even if it is done, substantial quantities of sand and grit are still going to wash down the drains when rain events occur. Along with that, we see a lot of cigarette butts, bottle caps, rags, plastic drinking bottles, and just about any other form of trash that you can think of.

To facilitate removal of solids and trash, they use grit settling basins which let the heavy solids settle to the bottom, screens which filter out the solids as the wastewater is flowing through them, or centrifuges which spin the wastewater in a manner that the solids are separated from the water.

There are many types and manufacturers of these equipment and I am not going to endorse any particular one today but I will say that all treatment systems should include a form of screening for removal of trash, sand, and grit. If we don't have that, the result is additional wear and tear on pumps and equipment. Equalization and detention basins and holding

tanks fill up with sand real quickly if it isn't removed before it gets to those particular types of equipment.

As I stated earlier, probably the largest concern with railroad wastewater is oil and grease. As most of you already know, oil and water have different specific gravity. This causes a phenomena of oil floating on the water surface. A basic unit called the oil/water separator uses the mechanics of oil floating on the water to facilitate removal of the oil. Wastewater comes into the box separator and is detained in the unit and lets the oil float to the surface. The water continues on through the unit, goes underneath the separator wall, and comes up and is discharged over the effluent. The oil that is separated out is held back behind the wall and can be removed by skimmers and pumps.

This is a picture of one. You can see the separator wall. This black area back here is the oil that is being retained. This is the skimmer bar that you can tip down and the oil will run into it to a pump on that end. The water goes underneath the wall, comes up over the top, and is discharged out through the discharger.

This unit, as I said, is very basic equipment. It is designed for the purpose of removing oil and does not remove other contaminants except for solids that settle to the bottom and eventually will fill it up. If there are any soaps or cleaners within the wastewater causing an emulsion, the oil will be held in solution and will not be removed from the water. In such a case, the oil would pass directly through the unit with the water.

This unit can be of various sizes depending on the flow rates through. It can be below ground where they usually operate by gravity flow. The gravity just keeps the water going through it. Or it can be above ground in which case pumping systems would be required to lift the wastewater to the unit. It can be indoors or outdoors depending on the climate.

Generally in facilities with washing operations where soaps are used, the oil/water separator and other treatment methods will be used in series with each other. The separator will remove the gross oils and free oils which are floating and then other units will remove the metals and the oils that are suspended in the water.

One type of unit that can deal with oil/water emulsions is what is called an emulsion breaking system. These units are similar to a basic separator except that prior to the wastewater entering the separator unit, it is mixed with acid to reduce the pH to a point below its isoelectric point of the soap being used. Generally that is around a pH of 4 or 4.5. This nullifies the emulsifying properties of the soap and again allows the oil particles to come together and get larger and then float to the surface. The pH must be adjusted back up to allowable levels before it is discharged from the facility. These units again deal mainly with soap, oil, and water emulsions. They neutralize the emulsifying properties of the soaps and allow the oil droplets to come together and float.

Another system that can be used to handle the oil/water emulsions is a dissolved air flotation or DAF unit. These units also remove metals and other contaminants suspended in the waste streams.

On this slide the flow goes through the DAF from left to right with influent coming into a well here and being pumped into a mixing tank and a compression tank and then into the DAF tank. A cationic or positively charged polymer is injected into the wastewater either into the wet well or somewhere in the system prior to the mix tank. It has to be determined where to put it in because it needs to have a certain amount of contact time with the waste before it gets into here. If it doesn't have enough time in contact with the waste, it won't work. If it is too much, then it doesn't work very well either.

A chemical neutralizes the ionic charge on the waste and again begins the coagulation process. An anionic long chain polymer is then added. The waste particles attach to the long chain molecules in the second polymer and are accumulated into even larger pieces. Compressed air is added at this point and it is mixed with the wastewater and put into a compression tank. This puts the water into a supersaturated state. When the wastewater enters the

DAF tank, the air is released from the supersaturated state and bubbles to the surface similar to when you open a can of carbonated soda. The bubbles that are released attach to the contaminated particles in the water and float the waste to the surface. The bubbles carry it up to the surface and it is skimmed off into a trough on the side and is discharged for disposal.

The treated water comes off the bottom. There is a little wall on both sides and the water comes up around the outside and comes over the weir at the top and is discharged.

This is another DAF system. It is similar in operation except that instead of mixing the air and compressing 100 percent of the wastewater, you will see that the waste comes in and goes straight into the DAF. The air is mixed to a certain percentage, usually about 15 percent of the clean water that is discharged off comes back around and has the air mixed in with it. It is compressed and then is added with the raw waste as it goes into the tank. This causes a lot less agitation of the raw waste, therefore less mixture of the contaminants and this seems to be a lot more efficient process than the other.

Another system of treatment would be electro-coagulation. This hasn't been used very much in the railroad industry as of yet, but I know some companies are looking at it. An electrical charge is introduced into the waste stream via a sacrificial anode. The electrical charge neutralizes the emulsion in the wastewater and it allows the contaminants to attach with a negative ion from the sacrificial anode. Then that is either floated or settled and removed from the waste stream.

Specific characteristics of your wastewater determines which method or combination of methods could be used. Treatability studies can be done on the waste stream to determine which chemicals are most effective with a specific waste. Again, the two major considerations affecting treatability of oily wastewater include:

1. What is in waste. If it includes soaps and alkali cleaners, it would be more difficult to treat than if it is just oil and water. The soaps hold the contaminants in solution and chemicals will be required to release them.
2. How waste is being handled. Gravity flow collection systems are better for treatment than are pumping systems. If pumping systems must be used, centrifugal pumps with high rpm's should be avoided. What they do is act like an egg beater and they whip up very tight oil/water emulsions that are extremely difficult to break apart. Positive displacement pumps such as diaphragms, screw pumps, or hose pumps tend to provide less agitation and allow for easier treatment.

I am aware that treatment of wastewater is a concern for only a few of you here. Everyone should be aware, though, that what they put down the drain is going to have to be treated. If you contribute waste to your facility's treatment system, make sure that those responsible for the operation of the system are aware of it. You may be adversely affecting the treatability of your waste without anybody even knowing it. Whoever is operating your facility should know what is coming in.

It also may be true that you are contributing something to the system that your facility is not permitted to handle.

Finally, I would like to say that there is not an endless supply of clean, fresh water in our world. As we use and contaminate the fresh water that we have, it is increasingly necessary that we treat and repurify it for future use. If not, eventually all the fresh water will some day look like some of this stuff. Water treatment is necessary so that some day you don't have to plug your nose and fight through the smell of oil and drink something like this.

I would like to thank you all for having me here today.

Mr. Van Huis: Thank you, Steve. Our next presentation is a standing committee session on material; bridge ties and timber availability and procurement. The presenter is Lowell Eby, director of material distribution on the Burlington Northern.

STANDING COMMITTEE

MATERIAL – BRIDGE TIES & TIMBER AVAILABILITY & PROCUREMENT

Lowell Eby

**Director of Material Distribution
Burlington Northern Railroad**

Good morning. Thank you for the invitation to be here. It is really a pleasure to be able to address you. Today I have come to speak to you about bridge ties and timber availability, timber sources and procurement.

Timber bridges come from three primary species or groups. They are oak, Douglas fir, and southern yellow pine. Due to the availability and other issues, southern yellow pine is the primary material used for large dimensional timber on most railroads including the Burlington Northern. Oak, when used, is primarily used for bridge ties on most railroads although eastern railroads are using it for occasional large structural timbers.

The Pacific Northwest is a primary source for Douglas fir. Over the past 20 years, several issues have arisen to shift the timber industry from the Pacific Northwest to the south central United States. In 1991, the States of Washington, Oregon, and California received a recommendation from the Inner Agency Scientific Committee to set aside 7.7 million acres of critical lands as habitat for the endangered Northern Spotted Owl.

In addition to this severe restriction on regional timber harvesting, there are several other issues in current legislative and legal debate. Of the 39 million acres of commercial timberland in the Pacific Northwest, 22.3 million acres are public lands. Environmental activists, most of whom oppose cutting of timber in national forests, have been successful in using the government appeals process to halt much of the logging on public lands.

In addition, state forest practice acts threaten to reduce the quantity of timber available on remaining private lands.

Western soft wood production has fallen 25 percent in the last five years. In 1989, 23.3 billion board feet were harvested compared to 17.4 billion board feet in 1993. Projections for 1994 show an additional decline of ten percent.

Due to the decline in availability of oak and Douglas fir, the next portion of this presentation will focus on southern yellow pine. This is a southern yellow pine forest in Mississippi. Large structural southern yellow pine bridge timbers come from five species of trees. The five species are long leaf pine, short leaf pine, loblolly pine, slash pine, and Virginia pine.

The greatest percentage of this type of bridge material procured comes from four southern states: Georgia, Alabama, Mississippi, and Louisiana. The following information is by state and was gathered from forestry commission reports and the United States Department of Agriculture Forest Service data. The data shows current forest lands in acres, the current timber types, and any changes that have affected timber increases or decreases.

Since the fifth inventory of Georgia's forest resources was completed in 1982, timberland now covers 23.6 million acres or 64 percent of the area of Georgia. The area of timberland has decreased by less than one percent or by 102,000 acres. Pine plantations, which are areas that have been regenerated by planting or artificial seeding, presently constitute 45 percent of all pine stands in Georgia.

The southern yellow pine group has had some recent declines. The most severe decline occurred in the short leaf pine which declined over 40 percent to 544,000 acres. The second

most abundant pine type is slash pine which dropped ten percent to 3.7 million acres. Areas supporting long leaf pine experienced a substantial drop of 23 percent to 520,000 acres.

About 62 percent of the annual harvest came from pine stands, 25 percent from hard wood stands, and over 12 percent from combination forest, oak and pine stands. Acreage and pine plantations less than ten years old presently constitute 20 percent of all pine stands in the state in contrast to 13 percent in 1982.

Natural disturbances such as fire, disease, insects, and weather damage about 240 acres annually. This is showing a southern yellow pine that is eight foot in circumference. This is the same tree showing a consistent circumference which is something that we are looking for.

According to Alabama forest inventory, forests make up 21.9 million of the State's 32 million acres or 67 percent. Recent surveys indicate this is the third largest commercial forest in the nation. The nearly 22 million acres of trees in Alabama consist of four major timber types: pine, pine and hard wood mix, upland hard wood, and bottomland hard wood. Alabama's timbered area by types generally have remained the same over the past 20 years; 7.4 million acres growing pine, 4.5 million acres growing a mixture of pine and hard wood, and 10 million acres growing hard wood. The total area of timberland of pine and hard wood forest types in Alabama has not changed since 1982 though changes in the makeup have been significant.

Natural pine stands continue a long-term downward trend decreasing by 25 percent. The short leaf pine experienced a 48 percent decrease. Pine stands increased by 81 percent and now comprise 46 percent of the pine type timberlands or 4.4 million acres. Natural disturbances such as fire, disease, insects, and weather damage about 198 million cubic feet annually.

This shows a log inventory that has been stored for winter millwork. This is the end of a southern yellow pine that is about 70 or 80 years old. Mississippi forest land is made up of 16.9 million acres. Of that, 28 percent is pine, 51 percent is hard wood, and 21 percent is mixed hard wood. Timber harvested from Mississippi between July 1992 and June 1993 was 1,276,000 board feet of pine and 382,000 board feet of hard wood. Fifty-three percent of the Mississippi lands are underproductive. Pine volume has only increased three percent since 1977. Commercial timberland needs forest management practices to reach its full potential.

Hard woods are taking over many sites where pine grows best because there is too little replanting immediately after harvest. The timber mortality has more than doubled since 1977 primarily due to several epidemics of southern pine beetles and the growing number of beaver.

It is estimated in Louisiana that forest lands make up 13.8 million of the State's 26.2 million acres or 53 percent. Forest land is divided into six forest type groups: long leaf pine, about 850,000 acres; loblolly pine, 4 million acres; combination forest, oak and pine, 2 million acres; combination forest, oak, and hickory is 2.1 million acres; combination forest, oak, gum, and cypress is 4.4; and combination forest, elm, ash, and cottonwood is 410,000 acres.

The average net annual growth for all species is 835 million cubic feet and the average annual removal of growing stock on all species is 920 million cubic feet. The average annual mortality due to factors such as weather and disease is 157.4 million cubic feet.

It should be noted here there was a great deal of variability in the forest resource information used. To prepare this portion of the report, some figures were rounded and some liberties were taken to reduce and simplify the quantity of data involved.

There have been a lot of statistics and information given out over the past few minutes that can be a little overwhelming. I stopped and asked myself if I heard what I just said, would I understand? I answered myself no, so here's a clear overview of what has been said. One fact is evident. Yes, there is a lot of bridge grade timber being harvested. The consensus of the four States based on current harvest statistics for bridge material and expected future growth, is the rate of timber supply should remain at its present level for the next five or possibly ten years depending on the market demands.

This is the type of timber that we would expect to see for the next five or ten years.

The public approves of harvesting timber to produce consumer products, but continues to be concerned about environmental impacts. Opposition to individual forest practices is due, in part, to lack of knowledge about forests and their management. Forest resources are widely perceived to be in decline. The public knows little about forestry and it doesn't like what it doesn't know. The key to support of the forest industry is effective public education about forest management practices.

What is the truth about the health of today's forest land? U.S. forest land is still about two-thirds the size it was in 1600 before expansion and growth of our Nation. More trees are growing in the forest today than at any time since the early 1900s. Today's annual forest growth exceeds harvest by 33 percent.

This is the end view of a southern yellow pine. It is approximately 75 years old.

The current forest management practices taught in colleges and universities and used by national forest services are divided into several sections. A management plan should include all objectives for land use and include such items as wildlife population, expected current production and regeneration for the future. Regeneration can be divided into two types, natural and planted. Natural regeneration involves more than letting nature take its course. It usually allows for certain dominant seed producing trees to be left thus allowing for natural dispersment and germination of seeds.

There are four methods available for natural regenerating pine: There is the seed tree. This is the most frequently used natural regeneration method in even aged management. The number of seed trees left depends upon size, species, cone-bearing characteristics, and site conditions.

The second is clear-cutting in strips. This enables you to make periodic harvest cuts while managing even aged units. The clear-cut strips may be of any length, but preferably about 200 feet wide. Strips should be perpendicular to the direction of the prevailing winds to ensure good seed dispersal.

The third is shelter wood. This entails leaving many seed trees, usually about 25 to 40 square feet of basal area are left per acre depending on the species. This is equivalent to 23 to 37 14-inch trees per acre.

Fourth is seed in place. Seed in place involves clear-cutting the stand after the peak seed fall but before the start of germination. This method is best applied during a four or five month winter logging period. As with the seedling in place method, this technique can be used only when an ample crop of seed is available.

Site preparation is usually desirable for regeneration. The types or combination of site preparation depends on seed crop and species of pine. In some cases, soil disturbance occurring during a logging operation is sufficient to provide good seed bed. Most of the successful regeneration of southern pine is accomplished by planting seedlings. This type of planting is more time consuming and costly.

Proper site preparation is essential for a successful planted or seeded pine stand. There are two options for planting. To plant by hand or by machine. Machine planting is a more economical method especially in the large areas. Hand planting is more efficient on small areas or where the terrain is very rough. The most favorable time to plant bare root seedlings is during the dormant season avoiding hard, frozen, and dry ground.

The decision on spacing requires several considerations. The advantages of wide spacing of trees are it is less expensive, about half as many trees are needed while producing the same volume of wood in 20 years and can delay the decision on product objective, pulp wood versus soft timber. Closer spacing advantages provide the grower an insurance against poor survival caused by equality of seedlings or loss from insects or disease. It also provides an early economic return from thinning. Soil should provide the ideal organic nutrients and competing vegetation should be reduced or eliminated.

Herbicides can be used to help control hard wood population in pine regenerated stands. This a southern yellow pine forest that just had one of its 10 or 12 year thinnings. Thinning a tree is accomplished by several objectives. Thinning will allow trees left to increase in size. Soft timber stands are thinned approximately 10 to 12 years until the trees are a specific size. If sites remain untreated, the time it will take for trees to become merchantable may double.

Large structural bridge timbers come from trees 60 to 70 years old. There are many factors which influence railway maintenance projects. Projects have become more complex. In addition, availability of wood product has been in larger demand with more efficient working schedules, just-in-time deliveries, and pressure to reduce inventories. Three factors to consider when purchasing future timber orders are as follows:

1. Most areas do not allow logging during wet conditions. This was after a 30-minute rainstorm. The loggers are probably out of the forest for at least a week or probably more.
2. High grade pine timber availability is greatest during the months of May through October when the weather is driest.
3. The best time for filling large orders is during the months of July and August when the inventory of large logs is at its peak.

In conclusion, to repeat again what was said earlier, the consensus based on current hard wood statistics for bridge material and expected future growth, is the rate of timber supply should remain at its present level for the next five or possibly up to ten years depending on market demands. Thank you very much. (Applause)

Mr. Van Huis: Thank you, Lowell.

At this time, we will have a brief update on our education committee with Bill Nelson.

STANDING COMMITTEE ON EDUCATION

Bill Nelson

Chairman

Thank you John. As many of you have heard, we have been doing some training programs. For about three years, I have been involved with them and they are bridge inspection seminars. We had a very successful one last April in Denver, Colorado. We had 40 students attend. We have a wide range of attendees from ironworkers, helpers, mechanics, to chief engineers and consulting engineers. So it is a broad-based program. The program owes its success to some very fine instructors and I just want to mention them at this time. We had Dave Franz from the Kansas City Southern participating, Joe Lileikis from Amtrak, Don Sorgenfrei from Modjeski and Masters, Don McCammon from HNTB in Denver, and Gary Lewis from HDR in Denver.

This was the first year that we put Gary Lewis on the program. I saw a presentation of his on bridge scour and it was an excellent program and didn't let us down. He did an excellent program for us in Denver as well.

We plan to do the same program in April, 1995, at the Denver Sheraton Tech Center. I would encourage all of you who have employees to send your people. We can handle up to 40 students. We won't turn away one or two extra, but we like to keep it about at about 40. We will be covering a wide range of bridge inspections. It starts out with what is an inspec-

tor? What are the responsibilities of an inspector? What does he have to do? What will he encounter on the job? We go from that into timber bridges, concrete and steel, and then we have miscellaneous items covered on the last day such as tunnels and culverts.

The program has grown and the instructors have gotten better and better and they deliver an excellent program. So I encourage you to think about sending your employees. I have made some copies of our instructors' outline that we use and I will put them on the back table should you be interested in seeing what we actually do day by day. I have also on the back of that an outline of the training manual and what is included. The attendees get that manual to keep.

We are also planning a program that will start in November, 1995, on a bridge repair program. I have asked several people to chair sections of organizing this. Among them are Mark Johnson, who is going to organize a section on bridge bearings; Dale Bartholomew, who will be working on steel bridges; Bob Carter, who will be working on timber bridges; and Tim Rich, who will be working on concrete bridges. That is not to say that they are only going to work on that portion, but that's their primary emphasis. We are going to have them prepare an outline for our meeting coming up this November. A year from now we will be presenting a bridge repair seminar and it will be in November.

This seminar came about primarily from comments that we received from the students. Over and over again they said you have taught us what to look for and what the problems are, but how do we fix it. We can't give them every way to fix something, but we will give them examples of how things can be repaired. That seminar is a three-day program also.

I just want to go over a couple of comments that we have received from some of the students. At the end of each class I summarize all of the ratings, and we have the students rate the individual section and the visuals on a rating of one to five. This year, our overall seminar rating was rated an average of 4.33. That is not too bad out of one to five. So they were pretty well pleased with everything.

Some of the comments that they made are as follows: One said they thought the presentations were well prepared and that the food was good. In answer to what was particularly good about the seminar, one said the portion on scour. We decided this year to add some videos at break time; instead of just breaking and going and standing in the hallway, we would show videos so they can go out, get their coffee and come back in and watch short videos if they wish. This worked out well. They said the videos were a good addition during the breaks.

Timber inspection was very good. The one fellow said he was new to timber inspection. There were good practical examples shown through slides. The harness versus the safety belt discussion was excellent. We actually show the differences between that for fall protection. The example on prestressed concrete beam design was good. Also, it says, the speaker's experience with steel structures was helpful and informative. The last statement from that same person was pin connection stuff was good. Then the last comments that I put down in the letter, they said the overall seminar was very professional. I just can't say enough for the instructors. They did an outstanding job. I put it together, but they deliver the material and they do a real good job. I highly recommend it to you and to your people. Think about it. It will be the first part of April and you will be getting that in a newsletter from Pat as to the exact dates. The place will be Denver at the Sheraton Tech Center.

Thank you. (Applause)

Mr. Van Huis: Thank you very much, Bill. This type of seminar is important to the rail industry today and for our survival in the future. We are getting these kinds of responses back from the public as well as from the railroads. So I invite you to attend or have your people attend. (Luncheon recess)

AFTERNOON SESSION

Tuesday, September 20, 1994

President Steele: Good afternoon, gentlemen. Our registration as of 1:00 o'clock this afternoon is roadmasters 240, B&B 86, suppliers 177, spouses 82, for a total of 585. Gentlemen, that is nice crowd.

Those of us on the board are running out of ideas for conference material so if you have any ideas for conference material for 1996, if there are things that you want us to bring before you, please list those ideas and we will do our best to bring that to you.

At this time, I would like to get started and invite Mike Bradley to introduce our next speaker.

Mr. Bradley: Our first presentation this afternoon will be introduced by the sponsor, Jimmy Neece.

Mr. Neece: Jerry Butler, chairman of the special subject entitled, "Gang Size and Equipment" is here today. Jerry is manager bridge maintenance with the Union Pacific in North Little Rock, Arkansas. Jerry.

SPECIAL SUBJECT

GANG SIZE AND EQUIPMENT

Chairman: J.L. Butler, Union Pacific Railroad

Co-Chairman: T. Paine, CSX

I have heard it said, "The tracks on which a railroad depends to carry its trains is like a finely crafted ring and bridges are the gems which adorn it."

The men who take care of and work on these bridges must depend on a blend of knowledge, skills, and resources in order to keep the gems sparkling. In some circumstances, they must be a jack of all trades, dealing with not only a variety of bridges but a multitude of other structures and/or facilities while other bridgemen are specialized dealing only with one type of structure or aspect of bridge maintenance or construction.

In my presentation of Special Subject No. 3, "Bridge and Building Gang Consist and Equipment," I have the privilege of reporting to you a brief cross section of the different types of gangs and equipment being used by today's railroads. Primarily, I plan to discuss bridge maintenance gangs; however, I will touch on building maintenance.

The reference railroads of this report structure their bridge and building gangs in very similar ways. Each respective railroad may vary widely depending on the number of bridges, buildings, or other structures that are their responsibility. I would like to take this opportunity to thank those of you who responded to the questionnaire. It really helped in preparing this report.

I would like to preface my report by saying that, by and large, short line railroads tend to contract the maintenance and construction work on bridges and buildings. For this reason, the content of this paper is representative of the major Class I railroads who perform most of the maintenance and construction with in-house labor. The labor force of the major railroads work under a Collective Bargaining Agreement. Work rules for these crafts are detailed out

in these agreements and lend to the similarities of gang consists and the work the gang performs.

The trend in building maintenance seems to be toward contracting almost all the work performed on buildings. Some railroads simply do not perform building maintenance with in-house labor. It is all contracted. A typical building maintenance gang consists of one person, generally a foreman classification, who performs minor maintenance. Their duties will include repairing doors, windows, and small carpentry projects or painting. They drive utility vehicles loaded with an assortment of hand tools and power tools. These tools will include various saws, hammers, drills, wrenches, screwdrivers, and various other hand tools. Cordless battery powered hand tools are very popular because they do not require a power source and can be used anywhere. The territory covered by this gang will usually be either a terminal facility or on-line. In a terminal most of the work will be confined to a small area. The on-line territories may cover many miles but have very few buildings or facilities. On-line gangs will either be reimbursed for full expenses or paid per diem.

Railroads which have many buildings or facilities may employ several of the one man gangs or have gangs with up to four men. This allows them to handle larger jobs by combining the one man gangs or having the larger gang available. The four man gang will include a foreman, lead man or assistant foreman, and two carpenters or mechanics. The larger gang will be similarly outfitted as the one man gang. The truck will be a crew cab body style with tool boxes and overhead material or cargo racks for hauling any necessary equipment or material. The jobs handled by this gang may include renovation or remodeling the building, roof repairs, or large carpentry projects.

In any case, the personnel performing these duties must be knowledgeable of existing building codes within the communities and/or states where they work. They must be able to reference OSHA regulations. In many cases, when the scope of work is outside the range or abilities of the gang, such as plumbing or electrical work, the gang should be able to assist in the showing, bidding, awarding, and coordination of their work with the contractors. These major facility projects such as construction of office buildings, fueling facilities, and car and locomotive shops are exclusively contracted, along with most other heavy repairs like large remodeling work and major roof replacement due to lack of available manpower and other resources. Also take into account most of these older facilities have asbestos or lead containing material that has to be disposed of in a fashion that railroads are not equipped to perform.

The multi-purpose or composite gangs make up a large portion of the railroad bridge and building work force. These gangs perform work on timber bridges, culverts, minor concrete repairs, and if available, some building maintenance. It is seldom that these gangs perform steel bridge repair or any type of construction. This is due primarily to the necessary equipment needed for that type of work. For this reason, most railroads have specialty gangs geared toward steel repairs or construction which I will discuss later in the presentation. The composite gang range in manpower is from eight to four men. Although classifications for these men vary slightly from railroad to railroad they are easily recognizable. The gang will have a foreman, assistant foreman, and from two to six carpenters or mechanics.

The foreman is usually the most qualified man on the gang. He must be able to drive the truck and requires a commercial driver's license if the gang truck is over a state specified gross vehicle weight. He must be able to operate the equipment assigned to the gang. He should be tested on all rules, Chief Engineer's Instructions, railroad standards, and Federal Regulations which apply to his work and responsibilities on the railroad. Most railroads provide advanced training in these areas. He must have a basic knowledge of computers and be trained to use the applicable software utilized by the respective railroad. He must have interpersonal skills, communication skills, and leadership skills. Training programs to develop these skills are becoming very popular with railroads. The foreman is responsible for the day-to-day operations of the gang. The first and foremost responsibility is the safety of the men,

equipment, and railroad property. He must be able to recognize and eliminate the hazards as he encounters them, as much as practicable. He must handle the reporting of time rolls, inspection reports, and any other required reports for the gang.

The next classification or gang member is the assistant foreman. He must have the same qualifications as the foreman, since he will be in charge of the gang in the absence of the foreman. If the gang has equipment and no assigned operator, he will routinely operate the equipment. He may drive the truck if the gang does not have an assigned truck driver. The duty of filling out the daily inspection forms for trucks and equipment may be his responsibility. The foreman may delegate more responsibility to the assistant foreman in order to prepare him to hold a foreman's position.

The mechanics or carpenters are the muscle of the gang. As stated before, there will be two to six of these positions on a particular gang. These people must be qualified to use all types of tools and equipment. These people are a highly skilled labor force having entered in and completed service as a helper or apprentice. The helper is an entry level position which allows for on-the-job training and qualification to perform the duties of mechanics or carpenter. During the time spent as a helper, personnel will develop the skills required to handle tools, operate equipment, and learn rules, instructions, and Federal regulations which govern the duties of the gang.

In order to promote to mechanic, the helper may attend training courses and be tested on the requirements necessary to hold the higher classification. However, the majority of the knowledge and skill is learned from the senior men and on the job. Once promoted to the higher classification, the man should be competent to perform the various duties involved in bridge maintenance. There may be a welder assigned to this gang. This is the case with some gangs that may perform light steel repairs. If so, this man must have formal training in structural welding courses and pass any required tests.

The duties of these gangs are primarily geared towards timber bridge maintenance. These gangs change out timber caps in kind but some railroads use concrete caps. They may add stringers to a cord to strengthen the span. They remove worn out stringers from the cord and install new stringers or may completely renew the entire cord. They post piling or may frame the entire bent. They tighten hardware on the bridge, replace braces, clean drift off the bridge, clear vegetation, and spot in ties. If scour occurs, the gang will place rip rap to hold the bridge in place and prevent loss of penetration of the piling. Some railroads use this type of gang to replace entire tie decks. They may convert open deck bridges to ballast decks by installing floor boards or may replace the floor boards on existing ballast deck bridges. They surface and line bridges. This job is particularly important when track surface and line gangs or track tie gangs are doing work. They will usually have to line a bridge or surface a bridge behind the tampers. It is amazing how much a bridge can move left or right or rise or sink in a matter of minutes.

Another job required when tie gangs are working on the territory is to remove and reinstall ballast retainers which may be either wood or concrete. This not only helps with track tie installation, but it can prevent damage to the bridge and save substantial repairs. Some bridge gangs replace road crossings in line with tie gang projects. Composite gangs handle minor maintenance on turn and lift span bridges. They must be knowledgeable on how to operate the turn or lift spans. Most heavy repairs on turn and lift spans are accomplished by specialty steel repair gangs.

When another craft is performing work on a bridge such as installing ties on ballast deck bridges or laying rail, the composite gang may install temporary fall protection as required by FRA Bridge Worker Safety Regulations. In some isolated instances, bridge gangs construct and maintain access roads which parallel the railroad track and allow access to the tracks by all railroad forces.

In areas where snow is a problem, bridge gangs maintain snow fencing to lessen the effects of drifting snow. Sand can also drift onto the track causing build up under the tie

plates and allow the rail to spread. In these desert areas, one railroad has eliminated this problem by planting willow-like trees along the track to break the wind and keep the sand from drifting onto the track. They employ a bridge gang to continually maintain a watering system for the trees. The gang is also steadily planting new trees where old ones die and to expand the length of the shield.

Another duty of the composite gang is light concrete repairs on concrete span bridges. Minor spalling and cracks in the concrete can be sealed or patched. Heavy concrete repairs, such as epoxy injection into big cracks or bearing restoration are usually handled by contractors.

These gangs use a wide variety of tools and equipment to carry out their duties. The most important piece of equipment is the gang truck to transport men, materials, and tools to and from the job site. The truck can also serve as storage for these tools and other personal gear for the men. As referenced, all vehicles mentioned in this report will have two-way radios installed in them for communications. Although expensive, the two-ton truck is the norm for the composite bridge gangs. A typical truck will be equipped with a four-to-eight man crew cab positioned behind the driver compartment. It will have a flat bed platform with tool boxes mounted on the sides and underbody storage boxes. A hydraulic crane with a telescopic boom or an articulated boom with a winch can be mounted on the body. Although hi-rails are not required, many railroads are equipping their trucks with them. This makes getting to and from the job easier and you can carry material, tools, or equipment with you as you go. One restriction on the hi-rail boom trucks is boom capacity. For hi-rail operation, the heaviest boom you can mount on the truck must be calculated and installed by the manufacturer, even though heavier booms are available for off-track operations.

Man lift baskets which attach to the end of the boom are optional with these cranes and are useful for overhead work. Specialty steel gangs have a greater need for man lift baskets which we will review. Man lift cages which can be hooked into the winch cable of the crane are better suited for the composite gangs because it allows the gang to perform work below the deck of the bridge. The truck can be equipped with a hydraulic power take off or PTO which allows for hydraulic tools to be used. Chain saws, spike pullers, spike drivers, drills, and impact wrenches are a few of the tools available to the gang and most useful. A separate hydraulic power unit can be purchased and utilized if the truck is not available at the job site. Electric and pneumatic PTO systems with the same compliment of tools are also available for use by these gangs and some railroads equip the truck with two or three systems. Separate power units are also provided for the additional tool systems.

Along with the truck, the gang may have a trailer to haul material and/or equipment with them. The trailer should be heavy enough to be useful but not overload the truck. A trailer with a capacity of 12,000 to 15,000 pounds works well with a two-ton truck. The gang can haul all types of material with the exception of stringers or piling because of the length of the timbers. If these longer timbers are required for the job, they can be loaded on flat cars and shipped to the job location. Equipment can also be hauled on the trailer. Even though the truck has storage capacity for tools and equipment, additional storage space is often necessary. There are many ways to provide additional storage area. The gang may have a railroad boxcar which has been modified with shelves, bins, and dividers or bulkheads. A semi-trailer van that can be moved via highway from job to job may be used. Containers also moved via highway is another method of handling the need for additional storage. If the gang is headquartered and does not cover a large territory, a shop building may be provided for storage and office space.

The composite gang consist may include a separate piece of heavy equipment which can handle big materials. Flexible boom tie and timber handlers, sometimes referred to as bridge tie cranes or ribbed tired hi-rail equipped cranes, are two machines commonly used. Bridge tie cranes make installation of ties, caps, or stringers much easier for the people and reduce

the chances of accident or injury. The bridge tie crane can handle 2,000 pounds safely. Rubber tire truck cranes with hi-rails also make material handling much easier and safer. These cranes have more lifting capacity than bridge tie cranes and are rated from 15 tons up to 50 tons or more, depending on the availability or requirements of the particular railroad.

The truck crane is a versatile piece of equipment. It can handle rail cars of material, which makes distribution of materials very convenient usually at the job site. Virtually every size and shape of bridge timber can be handled by this machine. This allows for tie installation, cap replacement, stringers replacement, or even framed bent installation. The crane can be equipped with a clam shell bucket which can be used to place rip rap, pull drift, or ditch channels. When it comes to other types of heavy equipment such as backhoes, trenchers, man lifts, et cetera, some railroads feel it is more cost efficient to rent or lease locally when needed rather than own the equipment and provide it as needed.

The composite gang uses an assortment of small tools and equipment. These tools may be simple hand tools requiring the man to manipulate them by hand. These tools include hammers, mauls, claw bars, line jacks, ratchet jacks, hand saws, wrenches, and many others. The power tools used by these gangs may be driven by air, electricity, or hydraulics.

The most common power tools use air. Air tools include drills, impacts, and spike drivers. Of course, to run these tools the gang needs an air compressor. The size of the air compressor depends on the requirements of the gang. If only one tool is being operated at a time, a small portable air compressor will be sufficient. If more than one tool is being operated, which is usually the case, a bigger compressor will be necessary. This system is very reliable but is big and heavy to move around.

Another system of tools are electric tools. Electric drills, saws, and impacts are good tools if there is a power source available at the job site; otherwise, a portable generator is needed. The electric tools are larger and heavier than the air tools and usually are more expensive. Electric tools are probably the least used tools by bridge gangs.

The tool system gaining the most popularity today is hydraulic. The hydraulic power system can be incorporated into the gang trucks hydraulic system. The gang should have a separate portable hydraulic power unit as back up should the truck be unavailable.

There are several different hydraulic tools used by the gang. Spike drivers, spike pullers, impacts, chain saws, and drills are some of the most commonly used by bridge gangs. These tools are lighter in weight than either air or electric. Another advantage to the hydraulic system is being able to use hydraulic ram jacks to perform the work. Hydraulic rams are much more versatile than older mechanical or ratchet jacks. The compact build of ram jacks makes them easy to handle and store.

All three types of systems have their own advantages and disadvantages such as cost, maintenance, maneuverability, or convenience. All have a better application in specific instances but the advantages of the hydraulic system seem to outweigh the other systems. Most railroad composite gangs have a combination of the systems.

Composite bridge gangs will have a system of ladders and scaffold boards. Scaffold boards can be suspended at locations on a bridge to allow the gang easier and safer access to their work. Ropes, chains, or steel frames can be used to support the scaffold board.

Sometimes larger pieces of equipment may be required by the gang to perform their duties. When very heavy material handling is required, such as tall frame bents, driving piling, or setting panels of ties or decking, a locomotive crane can be utilized. These cranes are not usually assigned to a particular composite gang.

Steel repair gangs are specialized gangs dealing only with steel span bridges. The manpower consists of these gangs is fairly uniform from one railroad to the next. There is a foreman, assistant foreman, and three to four welders. The foreman, as with all other foremen, must be qualified on all the applicable rules, regulations, and standards associated with railroad operations. Additionally, the steel gang foreman, as well as the other gang members,

must be qualified welders. The qualifications are in accordance with the American Welding Society Testing and Qualification Requirements. The foreman and assistant foreman must be able to read blueprints and be knowledgeable of structural steel construction. They must be familiar with mechanical systems utilized in lift and turn span bridges. The assistant foreman drives the truck and usually operates any equipment included in the gang consist.

This gang covers a broader territory than the composite gang. They handle such jobs as welding cracks in steel members and cover plating steel members in order to strengthen the member. They replace loose or missing rivets and bolts in built up members and at connection points of the steel members. They clean and grease and adjust expansion bearings. The gang maintains the mechanical systems of lift and turn span bridges. Included in their duties on lift span bridges is maintenance of uphaul, downhaul, and counter balance ropes. The gang will replace steel members if they are worn out due to fatigue, loss of section, or damage from being hit by trains, barges, or vehicular traffic. The steel gang will surface steel spans with shims or grillages, if necessary. The gang may get involved with bridge construction if false work bents are required or the bridge is steel.

The steel gang will have a truck similar to the composite gang. A two-ton truck equipped with a boom and crew cab will fulfill most of the gang needs. A man lift basket is necessary to perform overhead work. The truck should be equipped with hi-rails to get to and from the work location by rail. A gasoline powered electric arc welder and combination compressor can be mounted on the truck. This eliminates the need for handling two separate units. Oxygen and acetylene cylinder storage boxes with hose reels should be mounted on the truck. This allows the gang to have the equipment they use with them at all times.

The small tools and equipment the gang requires are magnetic drills, hand-held grinders, rivet busters, punch outs, clamps, and a hydraulic jack system. The power supply can be a PTO on the truck and a portable power unit.

Most steel gangs will have rail cars included in the gang consist. A boxcar can serve as a mobile shop and storage area. Bolts, tools, and small equipment can be stored in the boxcar. The car can be equipped with work benches and jigs for layout work when the gang needs to fabricate steel members, cover plates, or gusset plates. A flat car is used for storage of raw materials used by the gang. Various sizes of plate, angles, channels, and bars can be stored on the flat car. This way the gang can keep a supply of material at all times. The flat car also allows for easy handling of materials.

Most railroads do not have many of these gangs for one reason or another. They may contract the steel work or not have enough work to support such a gang. However, most steel bridges in service today on American railroads are between 60 and 100 years old. They have carried multi-million tons of freight over them. Steel repair and maintenance on these older bridges is becoming a bigger and bigger budget item for most railroads, especially with the heavy-axle loads becoming more prevalent. One solution is to equip the composite gangs with welding equipment and tools, qualify men on welding and let them do the work in addition to that which they are presently performing.

Construction of major steel structures is accomplished almost exclusively by contractors. Some construction of steel and concrete trestles is also performed by contractors. However, most construction of trestles is achieved by in-house forces on most railroads. The construction gang's manpower consist will include a foreman, assistant foreman, hoisting engineer, assistant hoisting engineer, welder, truck driver, and five or six mechanics or carpenters. The qualifications to be foreman are the same as any other foreman with respect to the rules, instructions, and regulations governing railroads.

Additionally, the construction foreman must be able to read blueprints, know how to lay out the new bridge with surveying techniques, and have a working knowledge of construction practices and materials. He must have knowledge of pile driving criteria to determine proper bearing of driven piles. He must know how to read load charts for cranes. Formal training is

necessary and is provided by most railroads, although much of the foreman's knowledge is gained on the job through experience.

The assistant foreman should have the same qualifications as the foreman. His primary responsibility is training the men who work on the gang. He must assist the foreman with his duties but also make sure the men are working safely and productively.

The hoisting engineer operates the crane. The crane is usually a locomotive crane with a capacity of 80 to 120 tons. He must be formally trained and qualified to operate the crane. Usually he has been through some type of crane safety training. He has spent time learning how to operate the crane as an assistant hoisting engineer under the guidance of a qualified hoisting engineer. He must be able to interpret load charts for the crane and know how to maintain the crane mechanically. He must have knowledge of wire rope, slings, hooks, chokers, and how to rig materials and equipment to be handled by the crane. He must have a thorough knowledge of pile driving hammers and the operation of them. He must make daily inspections of the entire crane. This includes the boom, cables, sheaves, torrent and center pin, air system, brake system, and all safety appliances. The proper inspection forms must be filled out and given to the proper authority.

The assistant hoisting engineer position is primarily a training position. He frequently operates the crane and assists the hoisting engineer with the maintenance and inspection of the crane. When the assistant engineer is not operating the crane, he acts as a signalman for the engineer. He is in charge of rigging the pick and giving signals to the engineer during the pick. When driving piling, the assistant will help set the piling and monitor the hammer's operation.

The welder must be a qualified welder and performs various duties during the construction of the bridge. He will perform the duties of the mechanics or carpenters when not performing welding duties.

The truck driver is in charge of the gang truck. He must have a CDL qualification. He transports the gang and makes sure the truck is inspected and in good working order. His duties may include the procurement of materials and supplies for the gang. He will make sure that the machines and equipment are fueled and lubed and that the fuel supply is maintained. He will make sure the hand tools and power tools are in good condition. For example, he will make sure that the chain saws are sharp and that the compressors and generators are running properly and serviced.

The mechanics supply the labor for the gang. They have spent time as helpers or apprentices before becoming mechanics. There are not many formal training programs or qualifications for this position. Some railroads have construction practices training courses which educate the men on the basics of bridge construction. In these courses, they receive training on surveying and mathematics, concrete design and construction, and small tool safety and maintenance. These men prepare the existing bridge for the construction of the new bridge. They lay out pile guides, open up ballast deck bridge spans, and help the assistant engineer rig materials and equipment. They tie and set reinforcing steel, set forms for placement of concrete, pour and finish concrete, and tear out the old bridge span to allow placement of the new girders. If necessary, they lay track panels and dump ballast. Once the pilings are driven, they cut them off at the proper elevation. They must be constantly aware of and remedy safety hazards or report them to the foreman for remedial action. They, as with all bridge workers, must be knowledgeable of and comply with F.R.A. Bridge Safety Worker Regulations.

The construction gang will usually have a consist of railroad cars which will include gondolas, flat cars, and box cars in their complement of equipment. The gondolas will be used to transport the various containers, forms, and tool boxes used by the gang. The flat cars can be used to transport materials or equipment. One must serve as a boom idler for the crane when moving from job to job. The boxcars can store and transport supplies and materials for the gang.

The gang will have two or three containers which have been converted into shops, offices, or storage for the gang. The office container will have room in it to display blueprints, hold files or paperwork, and a desk for the foreman. It will be supplied with a radio and/or a cellular phone for communication. The shop container will be outfitted with tools and equipment which allow the gang to perform repairs to other tools and equipment on site. Vises, grinders, and a work bench are some of the items found in the shop. The shop should be supplied with handles for tools, oils, lubricants, rings and seals, plus a number of other items. The storage container will hold the hardware the gang needs on the job. Some of the hardware will include nails, bars, jacks, tools, wire, cable, nuts and bolts, concrete finishing tools, concrete vibrators, and spare parts for the many different machines on the job.

Gasoline and diesel are stored in approved tanks which range in capacity from 100 to 500 gallons. They are portable and can be set at the job site or picked up and taken to the bulk dealer for filling.

A two-ton stake bed truck with a boom crane is a useful vehicle for this gang. The truck does not need to be hi-rail equipped. It is primarily used to transport men and material to the job. If there is not a road access to the job, the men can be transported by means of a personnel carrier attached to the crane. This carrier is a modified pushcar with seats and brakes. If material is needed at the job site, it can be loaded into a gondola or onto a flat car for transport to the job with the crane.

An assortment of tool boxes is required for this gang. Chain saws, jacks, generators, oxygen and acetylene cylinders, cutting and welding equipment, air hoses, jack hammers, spike drivers, and pullers must be stowed away from the elements, vandals, or thieves. The gang has two air compressors on site. One cannot supply the air required to run all the equipment on the job.

The most important piece of equipment on the construction gang is the locomotive crane. These cranes are manufactured by several different manufacturers and, as I mentioned before, have various lifting capacities of 80 to 120 tons. The heavier cranes can handle the bigger pile drivers and piling. The hammers may be equipped with swinging, semi-fixed, or fixed leads. The smaller cranes may be rigged with a smaller hammer and leads. Both rigs will accomplish the required pile driving criteria for concrete piling. However, the big hammers may be too heavy to drive steel H or timber piling. This is usually the case when false work is required with the job. This problem is handled differently by different railroads. One may keep a second smaller hammer with the gang. Another may keep a second crane and hammer available to perform the job.

This leads into another gang utilized by some railroads. This gang consist includes a hoisting engineer and an assistant hoisting engineer. The crane is a smaller crane equipped with a smaller hammer and swinging leads. The crane covers a wide range of territory assisting all gangs with whatever work needs to be accomplished. Occasionally a composite gang is combined with a steel gang and short steel H pile trestles are constructed. On low tonnage branch lines where the cost of building a concrete or steel trestle is too prohibitive, timber trestles can still be the solution to heavy maintenance costs. The crane can pull heavy drift or beaver dams which are becoming a real problem these days to bridge and culvert owners.

The only other necessary equipment for this gang is a flat car for the boom idler, a gondola to carry slings, hooks, chokers, clam shell, or other lifting equipment, and a fuel car to store and carry fuel, lubricants and tools. The crane and operators become part of the gang they are working with.

The ideal gang is the final gang I wish to discuss today. This gang was formulated from the responses I received to a questionnaire from several railroads. The manpower would include a foreman, assistant foreman, four or five mechanics, and a helper. With recent downsizing, current work forces will have an average of four to five weeks vacation, and with the age group involved, illness and ailments associated with this group tend to create daily absences in the gangs.

With this number of employees, we can be assured of having a number of workers available to perform daily functions. All the men would be qualified welders, except the helper, who would be training. All personnel would have CDLs. They would be qualified on all rules, standards, and regulations governing the railroads. They would have formal training on construction practices, blueprint reading, surveying, concrete design and construction, and steel design and construction.

The equipment would include a four-wheel drive pickup or utility vehicle with hi-rails for the foreman. The gang truck would be a two-ton body with a four-door crew cab. The truck would have a heavy boom crane and be hi-rail equipped. The truck would also have a heavy-duty trailer package and trailer. The truck would be equipped with a hydraulic and air PTO and tools, including separate power units. This gang would also be equipped with a generator and electric tools for a backup system.

The gang would have two 40-foot semi-trailer vans. These would be used as a shop and office and storage for material and tools. The storage van would be stocked with spikes, bolts, nuts, washers, and other hardware. Jacks, track tools, air tools, chain saws, generators, cutting and welding equipment, lights for night work, ladders and scaffold boards could also be stored there. The second trailer could be used for a shop and office for the gang. The shop would be for repairing and servicing the machines and tools, layout work or storage for personal protective equipment. This equipment includes harness and lanyards, hard hats, safety glasses, hearing protection, life vests, and a first aid station. The office would have a desk for the foreman, scanner radio, and cellular phone for communication.

The gang should have a heavy machine available for use on certain jobs. The roving locomotive crane, truck crane, or tie handler crane could be used by several of these ideal gangs. Ideally, the gang needs other equipment such as backhoes, track hoes, dozers, and loaders. An inventory of these could also be shared by several gangs. Additionally, the gang would need a boat and trailer for over the water jobs as dictated by the F.R.A. regulations.

Logistics would command district or regional seniority territories to effectively utilize the expertise of the gang in an approximate 200-mile radius.

The last topic I wish to present today is the work being contracted routinely by most of the representative railroads. This work is highly specialized areas of bridge and building work. These areas include in place timber treatment, major steel member fabrication, flame straightening, I-Bar shrinking, concrete restoration, jack and bore culvert installation, asbestos removal, demolition projects, and painting of steel structures. The lack of equipment, expertise, and available company forces along with strict governmental mandates, leave the carriers with little or no choice but to perform this work with an outside contractor specializing in the particular field. As an example, recent rulings on lead abatement has virtually eliminated painting by company forces.

This has been a very brief and quick overview of the more prevalent gang consists utilized by the bridge departments on different railroads.

Again, I would like to express my appreciation and give thanks to those who responded to the survey sent out by the committee. Thank you. (Applause)

Mr. Bradley: Thank you, Jerry. Our next presentation is a change out from swing span to vertical lift at the Red River Bridge at Alexandria, Louisiana. The presenter is Ralph Eppehimer, an associate of Modjeski & Masters.

Ralph received his civil engineering degree at Pennsylvania State University in 1982. Ralph is a registered professional engineer in the State of Louisiana. His experience over the past 12 years covers construction, inspection, and repair of both fixed and movable bridges. Ralph was the designer on-site representative for technical support.

Please join me in welcoming Ralph. (Applause)

CONSTRUCTION OF UNION PACIFIC'S LIFT SPAN AT ALEXANDRIA, LOUISIANA, RED RIVER BRIDGE

Ralph Eppehimer

Modjeski & Masters

Thank you, Mike.

As part of the U.S. Army Corps of Engineers' project to improve navigation on the Red River Waterway, the Union Pacific Railroad's existing bridge at Alexandria, Louisiana, including a swing span, required modification. A vertical lift bridge was designed to replace the swing span with minimal interruption of rail and marine traffic service during construction. Construction began in November, 1990, and the bridge modifications were completed in November, 1992.

This paper addresses key structural aspects of the design and construction. The new piers for the lift span and towers encase the existing rest piers of the swing span and are founded on rock near the riverbed surface. The rock prevented pile driving, so special techniques were needed to seal the cofferdam sheet piles to the riverbed. A sequence of excavation and concrete placement was used to construct the new pier footings in segments without jeopardizing the stability of the existing rest pier footings carrying rail traffic. The swing span was temporarily modified including removal of its end panels so that it could remain in service in its shortened configuration while the slender lift bridge towers and counterweights were constructed atop the new piers.

The swing span was replaced within a rail traffic closure period of 12 hours as required. The contractor's successful span change-out method included simultaneous float-out of the swing span and float-in of the lift span by supporting both spans on the same set of falsework and barges. The steel through-truss lift span is 306 feet long.

Many past projects have included the replacement of movable bridge spans, for various reasons, while maintaining traffic during construction. However, this type of project requires specialized techniques, and each project has its own unique set of characteristics and circumstances. That specialization along with the wide variety of engineering, construction, and other disciplines involved, and the relatively short time available to coordinate and perform the work, is what makes these projects so interesting.

The intent of the following presentation is to highlight some of the key structural aspects of the recent modification of the Union Pacific Railroad's bridge over the Red River at Alexandria, Louisiana. The U.S. Army Corps of Engineers administered the design and construction contracts. Johnson Brothers Corporation was the General Contractor for construction. Union Pacific Railroad forces also performed portions of the work. The author was the on-site design firm representative during construction.

The existing single track bridge structure before modification included an open deck, steel, through-truss swing span about 358 feet in length. The open deck portion of the west approach consists of two steel through-truss simple spans each about 129 feet long, plus a 75-foot long steel deck girder span. The open deck portion of the east approach consists of three steel deck girder spans each about 60 feet long. The open deck portion of each approach is joined to a series of precast concrete, ballasted deck spans over land. The total length of the crossing between abutments is about 1,067 feet.

The existing bridge's history includes many past rehabilitations and partial replacements, so its components are of various ages. The oldest parts are some of the original con-

**Replacement of swing span with vertical lift span to modify
railroad bridge over the Red River**



One of the cofferdams for the new pier construction.



The original swing span with the new tower piers nearly completed.

crete piers which date back to the late 1800s. The swing span before its replacement provided a channel for navigation on each side of its center pivot pier and fender. Each channel had a horizontal clearance of about 158 feet.

To improve navigation, the existing swing span and its pivot pier and fender were recently replaced by a new vertical lift span. The geometry existing at the site and required for navigation allowed for the vertical lift span with its towers to be designed to fit entirely between the existing rest piers of the swing span. The existing approach spans were not modified. The steel through-truss lift span is 306 feet long (center to center of bearings), 50 feet deep at mid span (center to center of chords) and provides a navigation channel with 286 feet of horizontal clearance between the pier marine traffic with the span in the normal full open position and the river stage at the present normal pool elevation.

The normal lift of the span is about 38 feet. With the span seated, the low steel elevation of the lift span is about the same as it was for the swing span. Rail elevations across the bridge also remained generally unchanged by the project except for a slight increase due to changing from 119 pound to 133 pound rail on the open deck spans. Two new deck girder spans, 22.5 feet long from center to center of bearings, provide the transitions from the ends of the lift span, through the towers, to the approach spans.

The tower girder spans bear on the existing swing span rest piers toward the approaches and on the new tower piers toward the lift span and are not connected to the tower structures. Both towers are about 104 feet high from pier top to centerline of the counterweight sheave bearings on the tower top. The tower width, parallel to the track, is 15 feet between centers of the front and rear tower columns. The dimensions of the counterweight boxes, which travel vertically within the tower structures, are 9 feet by 21 feet by 30 feet deep.

The design and construction specifications for the project generally followed the American Railway Engineering Association Manual, including fracture critical member and Charpy V-notch impact test requirements for structural steel. The structural steel is mostly ASTM A588 Grade 50 weather-resistant steel, without paint. Miscellaneous metalwork including walkways is painted ASTM A36 steel.

Trusses and tower columns are mostly welded box members with bolted end connections. Welded plate girders were fabricated for floorbeams, lifting girders, and tower top girders. Stringers, girder spans, and bracing members were fabricated from rolled shapes. Bolted joints are mostly friction connections using ASTM A325 high strength bolts. Cast-in-place concrete for the piers, counterweights, and pier protection cells were required to have 3000 psi minimum 28 day compressive strength.

The project required both rail and marine traffic to be maintained during construction, except for occasional, scheduled interruptions of short duration when necessary. A maximum rail closure period of 12 hours was permitted to remove the swing span and install the lift span. Also, a maximum marine closure period of seven days was permitted for the span change-out operation during which time the new lift bridge was made operational.

Pier Construction

Construction started in November, 1990. The first major work on the site was construction of the cofferdams and two new piers. Due to the proximity of the towers to the existing swing span rest piers, one large pier was designed to encase the existing rest pier and support the tower and lift span at each end of the new lift bridge. Plan dimensions of the octagonal pier shafts are 36 feet by 39 feet.

Cofferdam and pier construction was mostly performed during the period from February, 1991, to March, 1992, with the construction sequence of the second pier lagging the first by about two months. Progress of the substructure work was hampered by a flood in the spring of 1991 and a marine vessel collision with the second pier's cofferdam in the fall of 1991.

The new pier foundations were designed as spread footings, similar to the existing pier foundations, only much larger. Although the dimensions vary between the two piers, the foot-

Right: Erection of one of the new towers after the end panels of the swing span were removed.



Below: The float-in of the new lift span, erected on barges.



ings are approximately 50 feet square by 10 feet deep. Founding elevations of the footings vary from 26 to 34 feet below the river's present normal pool elevation. The footings bear directly on a claystone/siltstone material near the riverbed surface. This rock material prevents pile driving. Construction of the new footings, which encapsulate soil and rock to the required founding elevations, slightly lower than the existing footing elevations, and placement of the footing concrete, were required to be done within dewatered cofferdams.

Since the sheet piles for the cofferdams could not be driven into the rock, the contractor used an auger to drill overlapping two foot diameter holes, a minimum of three feet deep, around the perimeter of each cofferdam frame to form a trench. The sheet piles were then set and their toes sealed and anchored to the river bottom by placing tremie concrete in the trench. Also, to maintain stability of the existing pier foundations, which continued to carry rail traffic during pier construction, a sequence of excavation and concrete placement was used to build the lower lifts of the new footings in segments. Rock was excavated in only one or two small segments at a time before those portions of footing concrete were placed.

A shelf, varying from 2.5 to 5 feet wide of undisturbed rock was left around the perimeter of each existing footing. The lower footing lifts were placed in eight segments each, with no two adjacent segments having been excavated before concrete placement. Threaded couplers were used to splice reinforcing steel across the vertical construction joints in the footing lower lifts. The upper lift of each footing was placed in one continuous pour. A problem encountered during the footing construction was control of water weeping upward through natural seams in the founding material, and in a couple cases, through bore holes into the excavated footing segments.

At the first pier, the solution consisted of encasing a pipe vertically through a footing segment as a relief passage for the water during concrete placement. The pipe was later capped and remained within the footing. At the second pier, the weeping problem was worse and seemed to increase as more concrete segments were placed. A drain system and impermeable sheeting were installed on the rock surface to relieve the water prior to placing concrete in the last two segments.

The pier shafts were constructed atop the footings in seven lifts each. The lifts varied in depth from four to eight feet except that the cap pours were about one foot deep. Repetitive work performed to prepare for placement of each lift included scaling existing pier shaft surfaces to sound concrete, drilling, and grouting reinforcing dowels into the existing shafts, raising formwork, installing reinforcing steel, pressure washing construction joint surfaces, and applying epoxy bonding agent to the existing shaft surfaces. Before the shaft construction, to assure that the existing shafts would be satisfactorily joined to the new shafts, tension tests were performed in the field on sample dowel bars grouted into the existing shafts. Those tests indicated that the design dowel sizes and spacing, the existing concrete strength, and the grout anchorage were adequate. The existing shafts were also reinforced by installing pre-stressing strands to tighten existing steel plate bands around the shafts. The plate bands had been installed in the past due to vertical cracks in the shafts. Bearing grillages and anchor bolts for the tower and lift span bearings were embedded in the upper lifts of the shafts. The caps of the existing rest piers remained exposed above the new pier caps, leaving the existing approach span bearings undisturbed. The temporary cofferdams were removed after the piers were built.

Swing Span Modifications

Structural steel for the bridge superstructure was shop fabricated mostly between April, 1991, and February, 1992, while the piers were being built. Just before the piers were completed, retrofit work was performed on the ends of the existing swing span. That work was necessary to shorten the swing span so that it would continue to carry rail traffic and have the clearance to open for marine traffic during erection of the towers on the piers and until the lift span was installed. A full truss panel needed to be removed from each end of the swing span,

Replacement of swing span with vertical lift span to modify railroad bridge over the Red River



The new lift span adjacent to the original swing span, ready for the span change-out operation.



The completed vertical lift bridge with the span raised.

and new temporary truss bearings needed to be established at Panel Points L1 of the swing span. The design drawings offered details and a construction procedure for the temporary swing span modifications which were basically adopted by the contractor. The swing span modifications required the conversion of the original U1-L1 truss hip hangers to span end compression posts. That was accomplished mostly by adding a channel section to each flange of the original U1-L1 truss members. To equalize stresses in the new and old components of the modified members, jacks were used to apply a portion of the panel dead load under the P.P. L1 floorbeams while tightening the bolts connecting the retrofit channels to the U1-L1 members. Retrofit portal bracing, stringer diaphragms, and span locks were also installed at Panel Points 1. Since the locations of the final lift span bearings were close to the swing span Panel Points L1, the lift span bearing grillages were designed to accommodate the temporary swing span bearings needed at P.P. L1. Some of the same anchor bolts were used for both the temporary truss bearing bolsters and the final lift span bearings. In April 1992, when the swing span retrofit work and the new pier work was ready, both end panels of the swing span were cut off at the same time to maintain span balance within about a six-hour rail closure period.

Calibrated jacks were used for this operation at Panel Points L0 and L1 to relieve the dead loads in the bottom chords and end posts in the end panels before they were cut and removed. The jacks were also used after the removal of the end panels to verify that the dead load reactions of the temporary bearings established at Panel Points L1 were satisfactory.

The stringers and truss laterals were also cut in the end panels near Panel Points L1 and the shortened swing span was then operable for either rail or marine traffic. The end panel floor system units remained in place on the piers to carry rail traffic until the next day. Temporary supports had been installed under the cut stringers, making temporary use of some anchor bolts that would later be used for the span locks of the lift span. On the next day, within another six-hour rail traffic closure period, the end panel floor system units were removed and replaced by the new tower girder spans. The girder spans were erected on a barge before the rail closure period with most of the track work complete and spliced with temporary girder extensions to make the transitions from the permanent tower girder spans to the swing span.

Tower and Counterweight Construction

Tower erection started immediately after the tower girder spans were in place on the piers with the erection of the second tower lagging the first by about one month. Many of the tower members were assembled on barges and then erected as larger units with the cranes. Similarly, the steel plate counterweight boxes with their bracing and lifting girders were erected on barges and then set into position within the partially erected tower structures. The tower tops were designed with jacking beams and eye bar hangers capable of supporting the final weights of the counterweights, ballast rails, wire ropes and balance blocks. When tower erection was sufficiently complete, the counterweight boxes were suspended from the eye bars and filled with concrete. The design required a minimum concrete density of 144 pcf.

Months before placing the counterweight concrete, test blocks were made to estimate the wet density and dry density of the concrete mix. A variable quantity of ballast rail sections, depending upon the concrete density, were also required to be placed on shelves in the boxes and embedded in the concrete for additional weight. During the actual pours of the counterweight concrete, the wet unit weight of the mix was monitored by taking samples. The average wet density as determined by the samples was about 146 pcf. For final weight adjustments to balance the span with the counterweights, pockets were provided in the tops of the counterweight boxes to contain cast iron balance blocks, weighing about 98 pounds each, ideally to account for about 4.5 percent of the weight of each counterweight. Before the span change-out operation, the weight of each constructed counterweight was also measured with two 550 ton calibrated jacks using the eye bar/jacking beam assembly designed into each tower top.

The sequence of building the piers, modifying the swing span, and erecting the towers and counterweights was critical to prepare for the span change-out operation. Counterweight sheaves, wire ropes, electrical power, and control circuitry also needed to be installed on the towers before the new lift span could be installed.

The other generally parallel work path to prepare for the span change-out consisted of fabricating and erecting the lift span, railroad trackwork, operator and machinery houses, drive machinery, and the electrical control system. Since this vertical lift bridge is a span drive system as opposed to a tower drive system, most of the operating machinery and electrical controls and their houses are centrally located at the top of the lift span. Operating ropes running along the top chords link the driver machinery to the towers. Preparation work on the lift span and the towers finished up at about the same time for the span change-out operation.

Lift Span Erection and the Span Change-out Operation

An integral part of the method of erecting the lift span was the contractor's method of replacing the swing span with the lift span. The plan was developed early in the project and it did raise concerns with parties involved in the contract. The basic concerns were for possible increased risks due to the plan to float-in the new span from the upstream side of the existing bridge and to have both the new lift span and the old swing span supported on the same falsework/barge assembly at the same time. However, the change-out method did later prove to be engineered and executed well. The lift span was erected atop the same falsework/barge assembly that would be used later to change-out the spans. Steel erection started in January, 1992, when the barge shipment of fabricated lift span steel arrived at the site.

Use of an old river bendway separate from the main river channel, just upstream of the existing bridge, as the site to erect the lift span provided protection during erection against river currents and traffic. The falsework/barge assembly included four barges arranged in two pairs. The span was mostly erected as two separate halves, with one half on each barge pair and then the halves were joined at mid span. The low steel of the erected span on the falsework towers was about 27 feet above water level, depending on the ballast level in the barge compartments. That height would put the lift span close to its final installed elevation on the piers when the river stage was close to the present normal pool elevation. Each barge supported three steel falsework towers. The arrangement provided for each lift span truss joint at Panel Points L2, L4, L4' and L2' of the 12-panel span to be supported on a falsework tower. Two of the three falsework towers on each barge were used for those eight-lift span support points. The third tower on each barge was for support of one side of the swing span during the span change-out operation. The other side of the swing span shared the center falsework tower on each barge with the lift span leaving about 5.5 feet clear between the adjacent spans when both were floating on the barges. Since the panel points of the swing span did not align with those of the lift span, additional diagonal truss members were added to one side of the swing span before the change-out operation to create bearing points for the span on the shared center falsework towers.

The seven-day marine traffic closure period for the span change-out operation started on August 2, 1992. On that first day, the lift span on the barges was moved downstream with tug boats to a position alongside the swing span. During that journey, cables from an upstream hoist were attached to the falsework/barge assembly after it moved into the main river channel in case additional control would be needed. Also, as the assembly approached the upstream nose of the pivot pier fender, bracing members and cables between the two barge pairs were removed to allow one barge pair to move into each of the swing span's navigation channels while the lift span straddled the fender walls. On the second day, the swing span was removed and the lift span was installed on the piers within the 12-hour rail traffic closure period.

The spans were interchanged through a precise sequence of adding and removing ballast water from the various barge compartments. The ballasting and deballasting procedures

raised and lowered the barge assembly as needed to move under and pick up the swing span and then set down and move out from under the lift span. Level barges needed to be maintained throughout the operation as the barge loading cases changed. The weight of the lift span was estimated at about 950 tons. The weight of the swing span was estimated at about 550 tons. Each barge and its falsework was estimated at about 300 tons.

Each barge pair was equipped with a system of submersible pumps powered by diesel generators and complete with interconnected pipelines and valves to each barge compartment. Each barge compartment also had a graduated rod for monitoring the ballast level. The crew was coordinated well for the ballasting operation and the system performed efficiently.

Due to the limited amount of elevation change that the ballasting operation could provide, the river stage had to be within about a two-foot range to be able to obtain the maximum and minimum elevations needed to replace the spans. Therefore, the river stage, which varied during the project within a range of 17 feet including a flood period, had to be close to the present normal pool elevation for the change-out operation. Replacing the spans at higher river stages would have been undesirable anyway due to effects of increased river current velocities. The river almost caused a problem when the stage rose to the maximum level during the 12-hour rail closure period, making removal of the falsework/barge assembly from under the lift span more difficult than expected. Other major work items performed to change the spans and restore rail traffic during the 12-hour period included replacing the swing span bearings with the lift span bearings on the piers, replacing the temporary tower girder span extensions with shorter permanent girder extensions, attaching counterweight ropes to the lifting girders of the lift span, and installing the rail joints at the ends of the lift span.

After rail traffic was restored, other work was required to make the lift span operational during the remainder of the seven-day marine closure period. That work included installing span locks, guide rollers, and centering devices. Connections and adjustments of operating ropes and the electrical system were made. The counterweight loads were transferred to the ropes using the jacking systems in the tower tops. The weights of the counterweights were also adjusted to balance the span with the counterweights and obtain the design pier reactions as determined by calibrated jacks at the lift span bearings. The lift bridge was operated for the first time on the sixth day for test runs. The bridge was put into service after the seventh day, although additional system adjustments continued.

Project Completion

During the last several months of the project, work continued to finalize the structure and system operation. Other major work that followed the span change-out operation included demolition of the existing pivot pier, fender, and swing span. Three of the four pier protection cells were also built after the change-out. The 25-foot diameter cells consist of sheet piles filled solid with concrete. Riprap was also required to be placed around the new piers.

The project was completed in November, 1992, about seven months ahead of schedule. The project was a good example of many disciplines successfully working together.

I thank you. (Applause)

President Steele: Past president John Horney was an integral part of that project at one time. That was before he left Union Pacific, but he did a fine job coordinating all the efforts and trying to make the changeout happen.

At this time it is customary to recognize the past presidents who are in attendance and I am happy to perform this task at this time. I ask that as I call your name, please come forward and stand in front of the podium. Please hold your applause until all have been introduced.

First, Wally Sturm, retired senior project engineer, Elgin, Joliet and Eastern Railway, president 1978-1979; Jim Budzileni, retired senior structural engineer, Illinois Central, president 1983-1984; Jim Williams, retired supervisor B&B, Elgin, Joliet and Eastern Railway, president 1984-1985; Don Lewis, bridge construction engineer, Illinois Central, president 1987-1988; John Horney, senior director of construction, Amtrak, president 1990-1991; Mark Walbrun, director of capital projects, Amtrak, Chicago Union Station, president 1991-1992; and Paul Saletnik, engineer of buildings, Chicago and Northwestern, president 1992-1993.

I appreciate all these gentlemen here. They assist in the program every year so let's give them a round of applause for their work. (Applause)

As I mentioned before, we owe a great debt of gratitude to the people involved in our seminars. As a token of our appreciation, we have a small gift to give them. First I would like to present Bill Nelson with one and then let Bill present to the others since he is the coordinator of the group.

Bill has helped us immensely in spearheading this seminar activity that we have embarked on and I can't say enough how much of a big asset he has been for us. What we have here is a pen and pencil desk set for him.

Mr. Nelson: Thank you very much. It has been a pleasure to work on the program especially with such fine instructors and other resource people within the Association. I have enjoyed it thoroughly although there are times when I scratch my head and ask myself why I got involved when I'm sitting there at 11:00 o'clock at night in front of a computer at home trying to keep my head up and get some things done. However, it's all worth it. It is really worth it when you have a room full of guys that are really interested in picking up some information on bridges. That makes it all worthwhile.

I think we only have two of the instructors here so at this time would Joe Lileikis and Dave Franz come forward please. That you very much. (Applause)

By the way, these same fellows say they will be back in April so we should have the same contingent of very fine instructors in Denver in April. Again, I am encouraging you to send your people to the program. I think they would get an awful lot out of it. Thank you.

President Steele: At this time I would like to call on Paul Saletnik, our immediate past president and chairman of the nominating committee to present us with our new officers for next year.

Mr. Saletnik: To fill the positions coming upon this year, the nominating committee recommends the following members for the position as indicated.

When I call your name could you please come up to the podium.

For senior vice president, Mike Bradley, project engineer, Conrail, Columbus, Ohio.

For junior vice presidents, Joe Lileikis, senior engineer structures, Amtrak, Philadelphia, Pennsylvania; and Robert W. Carter, B&B supervisor, Burlington Northern Railroad, Springfield, Missouri.

For treasurer, Donald J. Lewis, assistant engineer bridges, Illinois Central, Chicago.

For directors with terms expiring in 1997: Patrick L. Barrett, engineer construction and maintenance, Santa Fe, Kansas City, Kansas; Richard C. Dumar, manager architectural design, Union Pacific Railroad, Omaha, Nebraska; and David W. Cook, B&B supervisor, Montana Rail Link, Missoula, Montana. Mr. Cook was unable to be at the conference at this time.

Also as our constitution states, the existing senior vice president ascends to the office of President. That is John A. Van Huis of Wisconsin Central.

President Steele: Since the President has received no other nominations from the membership, I suggest we approve the election of the slate of officers recommended by the nominating committee by a voice vote. Are there any objections? All in favor of electing the slate of officers as presented by the nominating committee so indicate by saying "Aye."

Those opposed? Since none answered, I congratulate our newly-elected officers. (Applause)

I would like to bring Paul up here again so that he can make another announcement.

Mr. Saletnik: As you know, we extend an extra honor to members of our Association who have achieved some eminence and high degree of respect from their peers. We have the custom of maintaining a list of ten honorary members to our Association. Regrettably, just a few weeks ago, we received notice that Roy R. Gunderson, past President and an honorary member passed away.

The executive committee looked at candidates and we hereby make the recommendation of Jim Budzileni, who was President in 1983 and 1984. (Applause)

Mr. Budzileni: Thank you, Paul.

President Steele: We will now continue with the board and the business session of our meeting. Pat, would you give us the Secretary's report please.

SECRETARY'S REPORT

September 1, 1993, Through August 31, 1994

Total members, September 1		806	
New members since September 1		66	
Members reinstated		3	
			875
Less:	Deceased – Active	1	
	Associate	1	
	Life	10	
	Honorary	1	
	Dropped – Active	32	
	Associate	9	
	Life	1	
			55
Total Members, August 31, 1994			820

President Steele: Thank you, Pat. I would like to recognize Pat as she has done so much for this Association as well as for the Roadmasters and Superintendents as I have mentioned yesterday. So give her a hand, will you please. (Applause)

Don Lewis will give us the treasurer's report.

TREASURER'S REPORT

September 1, 1993, Through August 31, 1994

Checking account balance, September 1, 1993	\$10,400
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RECEIPTS

Dues	\$10,013	
Advertising	19,615	
1993 net conference receipts	39,410	
Bridge Inspection Seminar	19,375	
Interest on checking account	524	
Miscellaneous	80	
Transfer funds from money market	2,100	
		\$ 91,117
		\$101,517

DISBURSEMENTS

Salaries	\$12,697	
Payroll taxes	1,020	
Employee Savings	381	
Rent, utilities, ins. & taxes	2,906	
Office supplies	584	
Equipment purchase, rent & repair	1,372	
Stationery & printing	4,428	
Postage	2,366	
Proceedings (1992 & 1993)	24,736	
Conference	1,198	
Bridge Inspection Seminars	11,950	
Executive committee meetings	3,585	
Temp. office help & comp. cnslt.	1,245	
Bond for Secretary & Treasurer	270	
Miscellaneous	479	
Transfer funds to savings	15,000	
		\$84,217

Checking account balance, August 31, 1994	\$17,300
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Funds on deposit Advance Bank, Homewood, IL	\$47,624
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Total Funds, August 31, 1994	\$64,924
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Thank you.

President Steele: Thank you, Don. Next I would like to have Jack Williams come up and gives us the audit of our books please.

AUDIT COMMITTEE REPORT

To: Members of the American Railway Bridge and Building Association:

We, the undersigned, have examined the financial records and report of the treasurer for the period September 1, 1993 through August 31, 1994, and have found them to be correct as of August 31, 1994.

Respectfully submitted,

J.R. Williams, Chairman
W.C. Sturm
J. Budzileni

President Steele: Thank you, Jack. Next I would like to have Wally Sturm come up and give us the necrology committee report please.

NECROLOGY REPORT

Jack Williams has just informed me that Joel W. DeValle, former President of the Association just passed away last week. His name is not on the list.

To the President and members of the American Railway Bridge and Building Association: It is with grief and regret that we report the known loss of thirteen members through death during the past year. It is possible that other members have passed away during the year of whom we have no information. If you know of anyone, please report their names to the secretary. The following have been reported since our last conference in September of 1993:

L.K. Arnold

Asst. Gen. Frmn. B&B (Ret.)
AT&SF RY
Joined 1-1-62; Died 7-31-93

G.W. Christiansen

Chairman
Racine RR Products
Joined 10-9-72; Died 10-27-93

D.J. Duquaine

B&B Supv. (Ret.)
CMSP&P
Joined 10-9-72; Died 10-27-93

E.J. Rotondo

Asst. Supt. Mtce.
At&SF RY
Joined 12-3-82; Died 6-30-93

C.O. Sathre

B&B Supvr. (Ret.)
AT&SF RY
Joined 12-3-82; Died 6-30-93

G.K. Schlicher

B&B Supvr. (Ret.)
Conrail
Joined 9-26-67; Died 3-23-94

R.R. Gunderson

Asst. VP (Ret.)
Western Maryland RY
Past President of the
B&B Association - 1956
Joined 10-1-47; Died 11-18-93

N.N. Sorenson

B&B Supvr. (Ret.)
UP RR
Joined 9-18-67; Died 5-31-91

C.A. Hughes

Civil Engineer (Ret.)
Joined 9-13-65; Died 2-2-94

B.M. Whitehouse

Chief Fire Inspector (Ret.)
C&NW RY
Joined 1-1-27; Died 11-5-93

J.W. Martin

Master Carpenter (Ret.)
Seaboard
Joined 9-14-53; Died 5-31-94

H.C. Wiemer

B&B Engr. (Ret.)
BN RR
Joined 10-15-57; Died 4-10-94

I.A. Moore

Chief Engineer (Ret.)
C&EI RR
Joined 10-1-37; Died 5-12-93

Respectfully submitted,

W. Sturm, Chairman

Gentlemen, I would like to observe a moment of silence in honor of our departed comrades. Thank you very much.

President Steele: Thank you, Wally. Our next presentation is on wire rope and rigging and will be presented by Mike Parnell. Mike has had 13 years of progressive experience in wire rope, rigging, and crane operations in the mining, maritime, electric utility, pulp and paper, nuclear, and construction industries.

He has a Bachelor of Science degree in Business Administration from Central Missouri State University and is a member of the American Society of Safety Engineers, Crane Certification Association of America, Associate Wire Rope Fabricators, and the American Society of Nondestructive Testing.

Please join me in welcoming Mike Parnell.

WIRE ROPE AND RIGGING

Mike Parnell

Wire Rope and Rigging Consultants

We have a series of workshops that are going to be handed out to you and I would like to ask you to take a look down the center aisle here. We have cards and workshop packets that will be given to you. While they are doing that, just to let you know a little bit about us,

this is our workshop and this is an information packet. In the information packet, we have a technical newsletter that we send out to those that would like to be on this list. The technical newsletters can be used for safety meetings for your people around the different facilities. They have a quiz and answer key and generally deal with the rigging or crane type subject. It is a challenge and we always push to challenge our clients in gaining new knowledge or reconfirming things that they have learned at one time and maybe forgotten.

Our company, by the way, has worked for a number of organizations in the room. We do lift span bridge inspection specifically as they pertain to wire rope on the lift span, on the counterweight ropes and also on the up haul, down haul rope system. So from the inspection standpoint, that is available to you.

If you take a look inside the envelope, this particular little brochure is about who we are. It's Parnell Services Groups. There are three companies. One deals with wire rope, one deals with cranes and equipment, and one deals with crane and lift inspection. So that's available to you. If you would like any additional information on the company and its services, please review that and then you will be able to contact us in the future. We would love to hear from you.

The things that you have been handed out in addition to the workshop handout is the riggers reference card. I am going to ask you to take a look at that with me. It's a ten-panel section card, five on the front and five on the back. These are used by crane operators and riggers to come up with rigging techniques if they run into a problem or to help confirm rated capacity and rigging applications for various sized loads.

On the front side, sections one, three, and five are rigging capacities for wire rope slings, web slings, chain slings, rigging hardware, eye bolt shackles, turn buckles and so on. On the backside, we have section six where we have load weights by cubic foot, square foot, and sometimes we will give a guy an extra hand on knowing when he is lifting using a crane or the rigging. So

Journeyman Rigger's Reference Card

Sling Capacities

Size in inches	VERTICAL	CHOKE	12 Leg Basket	60°	45°	30°	Color Code (Optional)	Size in inches
1/4	1,100	840	2,200	1,940	1,580	1,200	White	5/16
5/16	1,700	1,300	3,400	3,000	2,400	1,700	Light Green	3/8
3/8	2,400	1,860	4,800	4,200	3,600	2,400	Red	1/2
7/16	3,400	2,500	6,800	5,800	4,800	3,400	Yellow	5/8
1/2	4,400	3,200	8,800	7,600	6,200	4,400	Light Blue	3/4
5/8	5,500	4,200	11,000	9,600	7,700	5,500	Black	7/8
3/4	6,800	5,000	13,600	11,800	9,500	6,800	Orange	1
7/8	8,000	5,800	16,000	13,600	10,900	8,000	Gold	1 1/8
1	9,200	6,800	18,400	16,000	12,800	9,200	Dark Green	1 1/4
1 1/8	10,400	7,800	20,800	18,400	14,700	10,400	Purple	1 3/8
1 1/4	11,600	8,700	23,200	20,400	16,300	11,600	Grey	1 1/2

Load Factors

To find c (hypotenuse)
Given $a^2 + b^2 = c^2$ Sample $4^2 + 3^2 = c^2$ $16 + 9 = c^2$ $25 = c^2$ $25 = 5$

Tension in c = $\frac{\text{length c}}{\text{length a}} \times \text{share of load wt}$ $\frac{c}{a} = \text{Load Factor}$

Given length c = 10' and length a = 8', what is tension in c?
Solution: Tension in c = $10 \times 5,000$. Tc = $1.25 \times 5,000$. Tc = $6,250\#$

How much tension in chain come a-long A?
Ten in A = $\frac{3}{4} \times 4,000$ Ten in A = $12,000\#$

Offset C.G. $\frac{10,000\#}{10,000\#}$

INVERSE PROPORTION TO DISTANCE

Hoist A tension $8 + 2 = 10$. $\frac{10}{10} = 20$
Hoist B tension $8 + 2 = 10$. $\frac{10}{10} = 80$
20 x 10,000 = 2,000
80 x 10,000 = 8,000
A = 2,000 + 1/2 beam wt
B = 8,000 + 1/2 beam wt

Sling Capacities

Size in inches	VERTICAL	CHOKE	12 Leg Basket	60°	45°	30°	Color Code (Optional)	Size in inches
9/32	3,500	2,620	7,000	6,050	4,950	3,500	Must be tagged for length & strength	9/32
1/8	7,100	5,300	14,200	12,300	10,000	7,100	Must be tagged for type, length & strength	1/8
1/2	12,000	9,000	24,000	20,800	17,000	12,000	Must be tagged for type, length & strength	1/2
5/8	18,100	13,500	36,200	31,300	25,600	18,100	Must be tagged for type, length & strength	5/8
3/4	1,600	1,280	2,560	2,270	1,860	1,600	Should be tagged for length & strength	3/4
1-9/16	3,200	2,560	5,120	4,540	3,720	3,200	Should be tagged for length & strength	1-9/16
1-3/8	4,800	3,840	7,680	6,820	5,580	4,800	Should be tagged for length & strength	1-3/8
1-1/2	6,400	5,120	10,240	9,090	7,440	6,400	Should be tagged for length & strength	1-1/2
1-5/8	8,000	6,400	12,800	11,360	9,300	8,000	Should be tagged for length & strength	1-5/8
2-1/8	11,520	9,210	23,040	20,300	16,640	11,520	Should be tagged for length & strength	2-1/8
2-1/4	14,400	11,520	28,800	25,360	20,720	14,400	Should be tagged for length & strength	2-1/4

Block & Load

Angle	Block Factor	Line Pull in lbs	Block Load in lbs
180	0.00	6,000	0
150	0.52	6,000	3,120
120	1.00	6,000	6,000
90	1.41	6,000	8,460
60	1.73	6,000	10,380
0	2.00	6,000	12,000

Formula: Block Factor x Line Pull = Block Load

Assume frictionless system
A = 8,460
B = 12,000
C = 6,000
D = 3,120

Load 6,000 #

Rigging Hardware Capacities

Size in inches	Shldr Eye Bolt	Eye Nut	Turnbuckle	Shackle	Wire Rope Clip	Size in inches
1/4	500	125	520	400	500	1/4
5/16	600	150	600	480	600	5/16
3/8	1,200	300	1,250	1,000	1,200	3/8
7/16	1,800	450	1,800	1,400	1,800	7/16
1/2	2,200	550	2,250	1,500	2,200	1/2
5/8	2,800	700	2,850	1,900	2,800	5/8
3/4	3,200	800	3,300	2,200	3,200	3/4
7/8	3,800	950	3,900	2,600	3,800	7/8
1	4,400	1,100	4,500	3,000	4,400	1
1 1/8	5,000	1,250	5,100	3,400	5,000	1 1/8
1 1/4	5,600	1,400	5,700	3,800	5,600	1 1/4

Coefficients of Friction

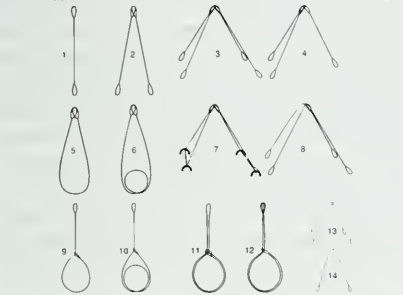
Material	Concrete	Friction	Material	Friction
Concrete on concrete	60	Continuous lubricated	Steel on steel	15
Wood on wood	50	Cast iron on steel	Steel on steel	10
Wood on concrete	45	Load on wheels	Steel on steel	05

Load Weights - Calculating

Materials and Liquids - Pounds / cu ft	Pounds / sq ft	Pounds / gal
Aluminum 165	Iron Casting 450	Steel plate
Asbestos 153	Lead 708	• 1/8" 5
Asphalt 81	Lumber - Fir 32	• 1/4" 10
Brass 524	Lumber - Oak 62	• 1/2" 20
Brick 120	Lumber - RR Ties 50	• 1" 40
Bronze 534	Oil Motor 58	Aluminum plate
Coal 96	Paper 58	• 1/8" 175
Concrete / Reinf 150	Portland Cement 94	• 1/4" 350
Crushed Rock 95	River Sand 120	Lumber
Diesel 63	Rubber 94	• 3/4" Fir 2
Dry Earth Loose 75	Steel 480	• 3/4" Oak 4
Glassine 45	Water 63	
Glass 162	Zinc 437	

Formulas and Information			
• H = Height	• W = Width	• L = Length	• d = diameter
• Area of square or rectangle = HW	• Vol of cube = HWL	• Area of circle = $\pi \cdot r^2$	• Circumference = $\pi \cdot d$
• The area of a circle is approx 88% of its diameter squared (diameter $\times$ diameter)			
• Load Weight (to estimate) = Volume in cu ft $\times$ 500 lbs $\times$ density factor			
			CG 05 10 20 30 etc

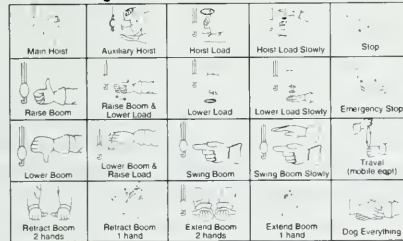
Hitch Types



#	Hitch Type	CG	Leg Loading	Load Control	#
1	Single Vertical	Above	One	Poor	1
2	2-Leg Bridle	Above	Two	Average	2
3	4-Leg Bridle	Both	Two	Excellent	3
4	3-Leg Bridle	Both	Three	Excellent	4
5	Single Wrap Basket	Both*	Two	Average	5
6	Double Wrap Basket	Both*	Two	Good	6
7	Two Single Baskets	Both**	Four	Poor	7
8	Inverted Basket & 2-Leg Br	Both	Four	Excellent	8
9	Single Wrap Choker	Both*	Single	Average	9
10	Double Wrap Choker	Both*	Single	Good	10
11	Double Choker Right-up	Both*	Two	Good	11
12	Double Choker Eyes-up	Both*	Two	Poor	12
13	Double Inverted Baskets	Above	Four	Poor	13
14	Single Inverted Basket	Above	Two	Poor	14

[never use as single hitch below CG] [compounds loading at pick points]

Crane Hand Signals



Checklists

Rigger's Checklist	Operator's Checklist
• Wind, temperature & visibility • Crane & load foundations • Load weight, height, width & length • Load's CG, pick points above or below • Attach point positive or freely rigged • Crane capacity at maximum radius • Head height, hoist ht., horizontal travel • Power lines, obstructions, load flexing • Hitch: Single vertical, choker, basket • Brdle 2, 3 or 4 leg, rated spreader bar • Slings: wire rope, web, chain, mlt mesh • Rigging gear & hoisting eqpt inspected • Tailboard meeting, communications • Signaller, tag lines, spotters • Sketch & outline procedure	• Wind, temperature & visibility • Crane & load foundations • Load weight, height, width & length • Deductions for extension, jib, block, etc. • Radius verified for pick, swing & set • Crane inspection: controls, hydraulics • Inspect brakes, outgiggers, rotation • Inspect boom, wire rope, pendant lines • Inspect blocks, hooks, rigging gear • Power lines, obstructions, hoisting ht. • Load stability, hook centered over load • Load is free for lift-off, not in a bind • Tailboard meeting, communications • Signaller, tag lines, spotters • Sketch & outline procedure

WARNING: Refer to hoist & rigging equipment manufacturers' specifications for proper applications and limitations. \$4.95 U.S.

R34 WIRE ROPE & RIGGING CONSULTANTS, INC. PO Box 728 • Vancouver, WA • 98666 • U.S.A. (208) 256-5730
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some of the things we will be dealing with in the next 30 minutes are sections 7 and 8 on the back of this card and they outline different hitches as they pertain to load control and stability.

When I was asked to come to do this I thought we would just do a couple small workshops that may help your people, not specifically you, but being able to turn around and help inform some of the people that work with you in the field on rigging applications. This is not a one-way communication program, so if you have any questions or observations, please raise your hand and interrupt me and we will see if we can deal with them as we go along.

On the first page, one of the things that I think that some of the people in the field need a better understanding of is one page of about 70 that we use on the rigging workshop handbook when we do a two, three or five-day rigging school for journey-men level which would be your mechanics, carpenters, assistants, and your operating engineers, but also for the master rigger level.

In this particular example, I would like to share with you an example of a crew that was set up to lift a load weight of 6,300 pounds. I need to ask you what is the general design factor in rigging applications? Five to one is absolutely right. What they did was set up between a 6,300 pound load and they had a tensile strength catalog breaking strength of 31,500 on their hoist line. They did the same thing on the sling supporting that load. So they made the charge between the hoisting system and the loads and it created a rig with a five to one design factor.

Now, in between the hoist line ball and the slings holding the loads was placed a dynamometer. The other load scale was placed between the head ball and the slings and their purpose was to help find out some information about impact or shock loads. There are a number of ways to induce a shock load and to take a new wire rope on a crane and as a single part line hoisting a load up, load comes up, swing load over, and set the load down. If we have a loose

ball or loose hook and we over spool a little bit and the rope gets loose on the drum, we swing the unit over, pick up on the next load.

When we hoist up, what is happening back on the drum end? What happens to the rope back there if it was loose in the hoisting motion? Slack rope. Big, loose ropes. So as that load comes over and then down, once we start to hit a certain elevation, what happens to that loose rope? It starts to come down. So we have impact or shock load. How about if the load is struck and the operator is not able to get the load unbound so the signaler says to come down off the load a little bit and he says just to highball it. They will hit it on the fly and pop the load up out of the ground. Would that be considered a shock load? Somebody will do that out there in the world.

So in either case it's an impact load whether it's a free fall or whether it's popping the load up off the ground.

Now just in a simple test with a short boom crane conventionally on a friction rig, they lifted this load up and they started at zero inspection of slack. Everything was tight with full rpm and it popped the load off of the ground. Now they registered on the dynamometer at zero information for slack at the first pick. The load weight came up to be 6,700 pounds. Then they set the load back down to even grade touch and spooled forward three inches of extra rope. They set the dogs full rpm and popped the clutch. They popped this load off again with three inches of the slack and the dynamometer and the peak loads went up to 8,900 pounds. It's a diagonal state. It will hold the peak load registered during that lift. This is in real pounds. So it's 8,900 pounds with three inches of slack up from 6,300. They set the load back down and went up to six inches of slack, popped the load off the ground with just a little more head of steam and went up to 11.5.

The last one is with 12 inches the slack and the dynamometer registered 15,600 pounds.

Just for a bread and butter rough knuckle type test, the guys were finding out we have a little more load that gets experienced by the crane and by the sling. If they started at a five to one design factor, what they would finish with was 12 inches of slack in a system. Two to one. 15,000 pounds of loads. 15,000 pounds of load goes up into 21,000. There is an eight to one design factor.

How many times did the load compound in weight as far as the train was concerned? It started at 6,300. What did it finish at? Fifteen. So the load compounded in weight two and a half times.

Physically, one of biggest things we find out in rigging accidents is:

1. Unknown load weight.
2. Off-center gravity which causes instability of the load.

Then we have a hookup in the system, even a jostling or a flexing or a sudden boom chat or boom movement. Have you ever see a crane swing that looked like this with all that impact and whipping motion? You put a dynamometer on a regular rail crane and we may end up with 20 or 30 or 40 percent more load in a particular lift. Most of the time we are not reaching or not picking at the maximum capacity at that given radius. Maybe at 25 feet we have 60 tons. Maybe at 60 feet we have 22 tons.

When we have these hookups, we are not even close to 22 tons. It gets into our mind that we are not going to have any accidents. It's not generating enough additional weight. But when we really boom down or we are off to the side, we may be on the line and we can have a failure. What happens if the slings happen to be in bad shape? What happens if the slings are damaged? What is the design factor of the legs? It starts at a five to one in new condition. When they receive all that damage, what is their remaining design factor? Maybe it is down to a four to one or three to one and heaven forbid if it's two to one. If it's a two to one with two and a half times the load, like my dad would say, the load got to the ground faster than we figured on because the impact load wasn't too severe, but all of a sudden the sling's integrity wasn't there to maintain. The quality of the rigging is really critical.

One of the things we want to share with the people back at our facility is to upgrade our inspection practices on the rigging. Whose job is it to inspect the rigging gear when a lift is taking place? The operator. He is overseeing it with the ground man working. The operator really needs to stay in the cab actually, but he has a ground man working for him. It is either the assistant operating engineer, oiler we call him, or one of the mechanics and he shall put that shackle or a sling to a load. They are accountable to inspect that sling. If the sling is no good, we are not going to save anybody's life by using it again.

What are we going to do? Increase the risk and cause maybe a loss of load or loss of life. So when we teach rigging, we want to make sure that's on a rigger's checklist. By the way, if you look on the back of your card to section 10, you see a rigger's and operator's checklist. Now down at the bottom there you see rigging gear and hoisting equipment inspected. Those are all part of it. When we put the gear away, what do we do again? Inspect the gear because there's no reason to put a loaded gun back in the old crib. That is when slings get damaged; during the lift.

We didn't see when we turned was that we flipped the lid over and laid the load over. That's when the cutting action takes place on a sling body. Before we put the slings or the gear away, we need to make sure we have our guys looking at the gear before we stow it.

This sure opened our eyes to when we could open a load up, 10, 12, 18 inches, it free falls. We can sure take a machine over. What happens is we have this: Hold a chair out in front of you straight if you can. Now we have a crane that has a load out at maximum radius for capacity. If we have an additional load put down by shock load, we push down, and you can see which direction Jim, who is holding the chair, is going. Forward. Where is his center of gravity? It's over his feet and right now he has the chair out here, the center of gravity is on his front toes hopefully. Hopefully the center of gravity is behind his toes. But when the load goes down with the additional force on a crane, it pushes down. It pushes the crane forward. The minute the center of gravity passes that tipping axis, we are done because what it does is cast the load out. The load casts out and the crane is already tipping. Where is it going to go? Out. Too much load, too far out, and crane tips over.

When we teach rigging we try to keep in mind from a load control and/or stability standpoint, and we are looking, by the way, on section 7 and 8 rigger's reference card. When we teach load control, we sort of approach it with maintaining load with a north/south and east/west concept. We want to make sure that we have the load control in the north/south plane and east/west plane. So if we do that, it's one of these we are going to have to break a syringe to drop the load. Something else is going to happen if we hold that load in those four directions. We want to be able to rig this thing up so that in as many times as possible it's with a positive attachment. When we talk about rigging, what do you think it means by a positive attachment? It can't slip. We have a hold of the load. It's from crane hook to shackles to load. Crane hooks to slings to choker hitches running space portion of the load.

Would you consider two open baskets to be a positive attachment hitch? No, it's not. It will work as it's sort of like a big fork lift. We can get up underneath the load like this, but it's not adhering itself to the load.

So in rigging, as we take a look at it and teach this way, there are five good ways to rig a load up and two bad ways. Out of the five, we are going to have a series or sequence that Jim and Allen and Lee and I are going to take a look at it. They are going to come up and the four of us are going to come up with maybe a half a dozen ways to do this. One of us might come up with a way. Let's put a big long sling right underneath the whole thing right in the middle and pick up on it. Sort of a Billy Bob rigging concept. It's trying to lift this load with center slings. So that would cross over to the two bad ways. Out of the five good ways, we are going to end up with the problem existing from a safety standpoint. One is maybe a little safer than the other.

Availability of equipment, manpower, time required to rig it up and cost. We can build a million dollar lift for something but it actually may be a little more cumbersome and labor

intensive to attach the thing rather than the three or four simple things. So there are five good ways we want to get down to. Maybe we won't take number one or number two, but number three is very adequate and melds in with what equipment we do have and the people that we do have. Let's go ahead and put it to work.

Let's take a look at numbers 1 through 14. You also have them on your cards. What kind of hitch or which number hitch system did we create there? Thirteen. Everybody else take a look at number 13. Two inverted basket hitches. What is the potential? Do we have the load controlled and if we state this, do we have the load controlled on the north/south position? No, we do not. How about in the east/west position? Do we have it there? We have two separate sling systems there so we have east/west because they are not talking to each other.

Do we have north/south? No, we don't have it. The shorter the slings or the tighter they are to the load, the more potential we have for running.

Now, if you turn your card over back to the front side with me, this is just a tool. On section five at the bottom is coefficient of friction. Now these are steel slings on a steel crane hook. What is steel on steel? What is the coefficient of friction for metal on metal? Ten percent. So the idea is if we get a little more load on one side, on the north side than on the south side by swinging or by some tilting action, all we have is 10 percent willing to hold this force. Once we exceed that, potentially we are going to have a load that runs. That running load can burn those slings, can cause enough of an upset to put a dock load out from whatever is connecting those slings to the load. It can be a big enough jar and rip part of that load apart.

Look at section 7 and 8. Look at it from a load distribution standpoint. Down in the little bar chart underneath on section 8, what do you show for number 13 for hitch type? What do we call that? Double inverted baskets. How can we rig that below the center of gravity? Above the center of gravity? What if we rig it below the center of gravity? Do we gain or lose stability? We lose stability meaning our pick points are down low on the load. They are down at the bottom of the box. Our center of gravity is up higher. The walls are coming tighter around the center of gravity and if we have some slippage and the center of gravity passes through that wall, we are done. We can't hold it back. That is why if the pick points are above the center of gravity we have at least more control. We won't have a complete flop.

What does the next column say? On leg loading what does that say for number 13? Four legs carry loads because we have two baskets. That's a good way to distribute the loads, isn't it. How about load control? We already decided it was not a very good concept.

We have four sling legs here and we are going to build this. What did we just build there? What do we have with a sling hitch. That is a four-legged bridle. That is a number 3, isn't it? How is that for load control? It is really good because we are shackling positive attachments to the load.

How is it for leg loading? How many legs are taking the loads? I have to defend this in a court of law. We do accident investigation and this is one of the things that we have to learn about four leg lifts. If we don't have any way to adjust these legs, we are in deep trouble. Four sling legs we grab out of a crew truck and slap on a crane hook and we have the pad eyes absolutely welded right in the right spot. Those four slings we grabbed are hanging down off that hook and sort of look like a roller coaster. One is 10 foot, one is 10 foot 1 inch, one is 9 foot 11 inch and one is 10 foot.

You know one short sling leg out of the four will cause cross loading. We really can't run the risk and it is very common. You pick up on a four point lift like this and it's very common to take a two by four, go around and hammer and thumb the slings. What is happening is we have two legs take the load, the two shortest combined legs diagonally are taking the load and two opposing legs are flapping in the breeze. What does that do to the pad eyes? They are attached to pad eyes that they are attached to. It's a double load there. What about the shackles making the connection? It's a double load there, too. So instead of what we are

thinking about a five to one design factor for rigging right to the capability of the slings, what is the real design factor? Two and a half to one. What if we free fall it 12 inches? We are done, so rigging applications contribute to the accident.

They were perfectly good slings out of the box but all of a sudden we have cross loading on the four points and we are in big trouble. Do we have north/south control? Yes. Because they are all bound up at the hook. How about east/west. It looks good from a control standpoint, but we really have to be careful when we do a four point like this.

We contract rigging jobs from time to time around Portland. We don't rig a four way with four legs carrying quarter, quarter, quarter, all the way around. We will just take two legs and carry the load. So we need to make sure we have enough rigging gear in there to take that full load when we are teaching our guys to rig.

Let's take a look at this and see if we can find a solution to this. Which one is that? What kind of hitch system is that? Number 8. What do we call it? Inverted basket and two leg bridle. From a control standpoint, how about north/south? Do we have control this way? How about east/west? Do we have control that way? Those two north slings are going to keep that load from falling. The center of gravity in the load, those two short legs, will keep the load from rolling. What is the basket doing for us? Equalizing the load.

To the best of our ability we have taken three slings, two 10s and a 20, and gotten as equal a loading as we can possibly get just using bare slings and shackles. Now over the hook we have a little D to D problem. The bending diameter of hook versus bending diameter of wire rope. Maybe we can put a web sling in there. It will work, but we have to have the ability for that sling to make final adjustment just before lift off. So think about rigging concepts and being able to distribute the load all the way around, 25, 25, 25, 25, and we will put down here. Plus sling angle of course. We have to deal with that as that is part of our rigging school.

Those are only vertical loads. Now we are going to have to deal with whatever the angle is doing to us.

I am going to ask you to turn to the last page and I would like you to look at numbers one, two, three, four, five, and six and choose which one you think is best from a load control standpoint. One A or B? Which one do you think is going to give the best control of the load? How about 2 A or B? How many of you were raised with the idea of this in your apprenticeship? "This is your training? Shut up and do it the way I told you to do it?" Was that the case? That sounds familiar to some of us.

What we want to do is be able to explain to a new guy on the crew that here's why we do want to do it this way. Here's why we don't want to do it that way. In our training concepts obviously, hands on is always good and we do at least 50 percent of our programs hands on. It just doesn't make a whole lot of sense to some guys until you get out in the field and start rigging loads. That's where it makes sense.

Now 1 A or B, which one gives us best control and best stability? B. What do you have going for B? What is the good thing about B? We have a double-wrapped basket on each end. We have a double-wrapped basket there. There is a script and compression. There is a rule of thumb when rigging for two baskets or two chokes on the load. We do not exceed or should not exceed an equilateral triangle. So if that's eight, then this should be less than or equal to eight feet across the bottom. If you spread them more than that, steel to steel, you are more likely to slide one end certainly more than the other and it turns the load out so an equilateral triangle just from a basket or double choke.

How about 1 A? What is the matter with 1 A? What don't you like about 1 A? It will go back and forth across the top. So we have this condition here. We have a potential run. We have a potential slide. So we have all kind of possibilities there.

It's just sort of which one is going to jump up and bite us first. But those are the only slings that we have in the truck.

You remember we said five good ways to rig a load and two bad ways? Where does this one come in? The five or the two? The two. Are we going to rig that way? No, but that's all we have. No, we are not going to rig that way. We have to hold our ground when we start deciding good rigging practices and we are going to have to hold to it and use those slings in some other combination to get a better bite on that load.

The main thing is not knowing what the load weight is. That's a big killer in rigging and knowing the center of gravity is also. Once we attack that and we surround the center of gravity for the lift, those slings could literally be a foot apart on the center of gravity. As long as we keep it level we are going to hold it until we get from point A to B. The problem is getting the center of gravity passed through a wall. Then it's gone. Or we are drawing the slings. The sling's friction just isn't going to hold.

Two A or B, what did you pick? Which one is the good one? A is the good one. Do we have north/south control? Yes? How about within reason. How about east/and west? How about 2 B? What is wrong with 2 B? The center of gravity is trying to keep it passing through the wall one way or the other. The center of gravity is before the pick points.

Look at your blue card on section 7 and what kind of hitch is that? Number six. It's a double-wrapped basket. What does it say for rigging for below center of gravity? Number six? Both. What does the asterisk say there? Nerve use a single hitch below the center of gravity. Isn't that what we are doing here? Yes. If we are going to rig this double-wrapped basket on this chair up here, we are above the center of gravity, but not below the center of gravity. We can't control the load.

How about 3 A or B? What did we get there? A. How about north/south control? Do we have that? Yes. How about east/west? Good. That inverted basket is going to give us some equalizing when we lift up on the center of gravity. It appears to be to the south side and we have two short slings there and a long inverted basket. Just by looking at it, ballpark, how much more load is at the south end than at the north end? Just in net load? What kind of distribution of weight are we looking at based on where the slings are? A 75/25 load split or so. That is just a round figure. 75 percent of the load is on the south side and 25 percent is on the north side.

The pick points closest to the center of gravity are going to carry more load. Those two short slings will carry more net load than the north side, but always remember we have to figure sling angle on top of that. We do a lot of teaching about if you have an offset center of gravity.

The load has heavy concentration of weight at one end and now we are going to rig it. We have to put the hook over the center of gravity to make the load come up level. There is no other way about it. The center of gravity will always end up underneath the hook whether you want it or not. That's the absolute truth.

By the way, what is wrong with 3 B? What don't you like? We are going to lose that. So we have lost it there. What happens if somebody crisscrosses the slings? If they do this one from one cross corner over here and one from the other cross corner over to here? Diagonal baskets. What happens? You lose north/south and you lose east/west both. Absolutely. It is the worst way to rig a load and it's a great way to cut a sling up on top of each other on top of that hook.

So crisscrossing slings on inverted basket is a great way to have an accident in a hurry.

How the about 4 A or B? Which one is the best out of the two do you think? Let's take a look at this one. Do we have north/south control? East/west? Let's look at this one. North/south? Yes. How about east/west? We lost this one because we can run that with one opposing leg and we can't resist the rolling. Two legs will work, but one leg by itself on that far end is not going to help us. So there is a potential for run.

Five A or B? What are we looking at here? Which one would you choose? A or B? B is good. Do we have north/south. Yes. East/west? Yes. What is wrong with 5 A? It is hard on the slings. That is number one. Sling damage. Yes, you can tilt it because it's called a ring

basket and the basket runs through the shackles and pad eyes is right there. In this running action, we have steel to steel to hold the thing in place. Additionally, what is really taken a lot of load? The pad eye is in a shackle, absolutely.

You can calculate it out. Normally in this case it will come out that real line of force will be two times whatever the sling is seeing because it is pulling across horizontally the angle on the bisecting line. That is the real line of force.

How about 6 A or B? Which one do you like? B. What is wrong with A? We have a potential slide. We are way out of the equilateral triangle there.

They are six simple little loads but they are really starting to make us think how do I grab that load and hold it when I want to take it off that rail car or off the ground and set it to a new location? What happens in 100 percent of rigging jobs? Ninety percent of the time is spent bringing together, rigging it up, and unrigging it. Ten percent of the time is in the air. If we are going to lose it, it's going to be up here. So that's why additional crane movement is not necessary.

That's why adhering or grabbing the load and preventing it from moving is almost certainly a potential to our advantage.

Our focus today was to bring up some awareness about good rigging practices. Next we want to share with our people when we go back things that will help give them some insight as to when we step over the line, we are over the line, and there is no going back. A lot of times we can't stop the load. We can't reach up there and grab that load and stop it. So we want to implement good rigging practices. It doesn't hurt if we double rig a load, meaning rigging it twice. I don't endorse overrigging a load because we have a 15 and 20 and 30 to 1 design factor slings versus loads blow up just as fast as a two to one.

I appreciate your time and I thank you. (Applause)

Mr. Van Huis: Thank you, Mike.

Our next special subject is managing building maintenance and Tim Rich will introduce the committee chairman.

Mr. Rich: Thank you, John. I would like to introduce special subject number four on managing building maintenance. The chairman of this special subject committee is Dick Dummar. He is the manager architectural design on the Union Pacific Railroad.

Dick has 13 years experience with the Union Pacific involving new building design, remodeling existing structures, and interior renovation. Let's welcome Dick Dummar. (Applause)

MANAGING BUILDING MAINTENANCE

Richard C. Dummar

Union Pacific

Business is in the "Information Age." In the past few years, major business news publications cover stories and headlines consistently proclaimed one fact — "The Industrial Age is Over." Noted authors and speakers make their living from this great societal change. As a result, we may need to dramatically rethink our "Division 16" process for designing for buildings in the future.

Quite possibly, the media announced the end of the manufacturing age prematurely which is something it seems prone to do whenever technology is at issue. Look at the coun-

try's GNP. Doesn't much of it still come from its massive manufacturing base? However, both common sense and statistics clearly indicate a revolutionary change in society, and that the industrial age will never return to its same glory.

So what does this have to do with Managing Building Maintenance? In the information age, buildings will be factories of the future. Office workers are essentially the human machinery that process the information. They range from college-educated white collar workers to the multitude of support people sitting at computers, telephones, and pushing paper.

Buildings are no longer static shelters — a simple core and shell built speculatively or by manufacturing giants as monuments to their greatness. These new age industrial facilities dynamically come alive and bustle with activity. Inside, up to a third of these office workers "churn" or change places every year.

AND WHAT OF THE BUILDINGS?

In this presentation of management of building maintenance, I will try to address this question as it relates to the railroad industry.

THE BUILDING ENVIRONMENT TODAY

All railroad facilities departments that are responsible for the ongoing operation of sizable buildings are complex and uniquely different. In order to function in an effective and productive way, each facility department must provide a reasonable service level and balance many varying elements to obtain favorable bottom line results. Each facilities operation strives to be efficient and productive in carrying out its tasks. When considering all the elements affecting productivity in a facilities maintenance department, one quickly realizes the many complexities of this issue and the inter-relations of various elements that must be dealt with simultaneously to maximize productivity while maintaining service levels.

Computers, word processors, high-speed copiers, and advanced telecommunications equipment have automated much of the drudgery from office work. These technologies allow white collar employees to process larger volumes of information much faster than they could only a few years ago.

In light of these advancements, the time has come to pay attention to the individual office worker. How can we help workers perform better on the job, turn out more work with fewer mistakes, reduce absenteeism and job turnover, and in general, be more contented employees? The answer to these questions depend largely on worker comfort.

Because of a variety of factors, comfort is a highly individual experience. For example, building codes and standards set by the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) are intended to provide temperature conditions in buildings that are satisfactory for up to 80 percent of the occupants. Even where the 80 percent target is achieved, one out of five workers is still uncomfortable. However, it is not always the same person, as individuals temperature needs vary from day to day and even at different times of the day. For these reasons, 50 to 70 percent of people are not happy with their office environment at one time or another.

Studies have shown direct correlations between office productivity and temperature and other environmental conditions. The temperature and quality of the air we breathe, lighting, the degree of privacy we experience at our desks, room to work and storage space to reduce clutter, noise levels, and status as evidenced by our surroundings, all have a direct and even measurable influence on our productivity.

The following quotation was published in 1775 by Sir William Buchan, "...it is a fact that...man suffers most often from the effects of the air he breathes. It is not unusual to find an assembly of several people remaining several hours in a comparatively restrictive space, probably surrounded by candles which tend to use up the air, and also make it less clean for breathing purposes. The air which has been breathed over and over again loses its vitality..."

This statement seems to be as applicable today as it was then. The quality of air within the workspace needs to be of the highest quality. Therefore, the maintenance of the HVAC systems need to be of the high-est priority.

It is important to under-stand that successful energy conservation and good IAQ are highly dependent on building performance. Many IAQ prob-lems have resulted from inade-quate or inappropriate mainte-nance of HVAC systems.

One of the primary items in a proper maintenance pro-gram is proper care of the fil-tration system. Although obvi-ous, it is important to reiterate that filters only remove dirt from air that passes through them. No matter what kind of filters you have or how efficient they are, if air can bypass the filter bank, your filters are doing little good.

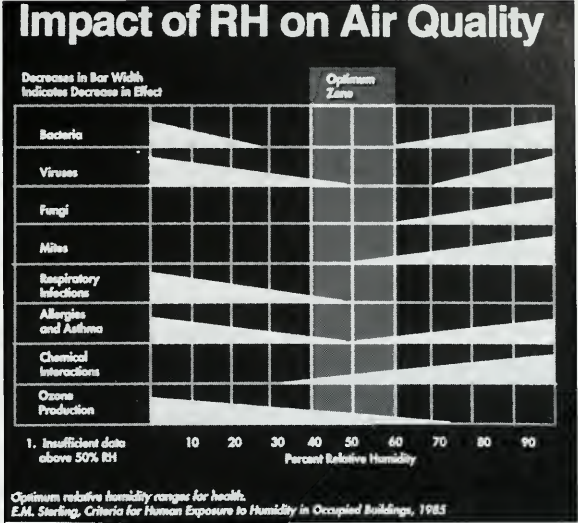
Dirty air bypass can be caused by space between the holding frames, filters not properly installed in the frames, damaged or torn filters, or filters which do not completely fill the opening. A frequently overlooked source of bypass is the plenum door located downstream of the filter bank and upstream of the fan. This is an area of negative pressure. Dirty air can be sucked through the door if it is not properly sealed with gaskets or if the fan is running when the door is opened.

Probably the most common cause of dirty air bypassing the filters occurs at the time the filters are changed. Invariably, some of the accumulated dirt load will fall off the filters when they are removed from the frames. Time must be taken to clean the floor on both sides of the filter bank after the dirty filters have been removed. It is important to make sure the pockets on bag-type filters inflate fully and properly so the clean air can freely exit from the filters, otherwise the dust-holding capacity will be substantially reduced. Non-supported extended surface filters can droop and fall into a condensate drain pan at lower air volumes on VAV systems and absorb moisture from the drain pan which results in microbial growth on the fil-ters and eventually in the ductwork and the conditioned spaces.

Standing water left in condensate drain pans can mix with dirt particles and eventually be transformed into "microbial soup." Porous supply duct lining is a collector of organic material that serves as a nutrient for fungi and bacteria. The high humidity normally occur-ring in supply ducts during the cooling season is an ideal environment for their growth.

Some indoor air pollutants come from building maintenance materials themselves, such as floor waxes, furniture polishes, carpet shampoos and washroom disinfectants. All chemi-cals should be minimized and their application should occur when buildings are vacant with good ventilation and maximum time until normal occupancy resumes. The same precautions should be used with insecticides, fungicides and rodenticides.

Because many IAQ problems are related to volatile organics, bacteria, fungi, mold and pollen, some HVAC equipment manufacturers are looking into the manufacture of low level ozone producing air handling system. Obviously, the ozone generating equipment would not be used when contradicted by high levels of ozone in the outside air, but could potentially



Air Quality in the work space.

minimize or even eliminate many of the bioaerosol and their organic problems in the duct-work and the occupied spaces. There are currently available portable area units which emit both low levels of ozone and negative ions at the same time. These have been used with great success in smoking areas and other areas with high concentrations of volatile organic compounds to reduce odor and particulates and to destroy harmful emissions.

Of course, good maintenance practices will treat cooling tower water with algicides and bactericides as well as other chemicals to maintain proper water quality. It is also useful for maintenance personnel to observe the different patterns of air movement when on the roof to make sure vapors from exhaust ducts, plumbing vents, or cooling towers, are not being drawn into supply air intakes.

The temperature controls in the HVAC system, which determine how the system operates, must be periodically checked for accuracy and proper operation. Improper operation of outside air dampers is a major contributor to indoor air quality and energy waste. If time schedules for preventive maintenance were not set up when first occupying the building, this should be done after a minimum amount of experience has been gained through the operation of the HVAC systems. And, last but not least, continual education and training of maintenance personnel is critical.

It is the facility manager who will be aware of the following items which can contribute to the overall success or failure of the HVAC system to provide the comfort we have been talking about:

- Occupant density within the space.
- How the occupied areas are to be used.
- Density of heat-producing devices such as personal computers, copiers, et cetera, within the individual zones.
- Areas producing localized contamination.
- Where and what type of partitions will be used; i.e., hard or soft surface, height, whether undercut at the bottom solid to the floor.
- Areas having particular temperature and humidity requirements such as computer rooms, testing laboratories, et cetera.
- And whatever other items that may be pertinent to your own particular facility.

The volume of air to be handled in a particular area is pretty much decided by the HVAC designer, as is its temperature. Where the facility manager's input is needed is in the type and effectiveness of filtration and the amount of humidification (or dehumidification) required for the facility.

It is the responsibility of designers and installers to ensure that building systems are effective in reliably providing and maintaining the desired indoor air quality. To do this, the design professionals must know what contaminant sources may be present and in what strength. They must also provide the owners, operators, and occupants with the most effective operating and maintenance procedures. Owners, operators, and occupants have a responsibility not to introduce new or stronger contaminant sources than can be accommodated in the original design, to maintain the mechanical systems, and not to modify the building without having appropriate adjustments made to the mechanical systems.

I believe that good indoor air quality with efficiency is achievable. The key to this is control through improved management of the factors affecting our indoor environment.

BUILDING EXTERIOR MAINTENANCE

Maintenance of building exterior elements accounts for a large portion of the time and money expended by facility managers over the life of a building. Historically, very little preventive maintenance is performed on these elements. As a result, the time and money expended often comes in a lump sum and emergency basis, somewhere in the ten to twenty year time frame in the life of the building. Typical "emergency" types of exterior problems include such major items as roof replacement, exterior wall, window repair and resealing, or major structural repairs.

Building exterior elements typically behave in a relatively predictable manner. Exteriors are subjected to movement and deterioration due to internal loading and established movement and weathering characteristics. Eventually the effects of the sun, wind, rain and building movement will wear away the materials or cause a reaction to the point that the structural or waterproofing integrity is compromised.

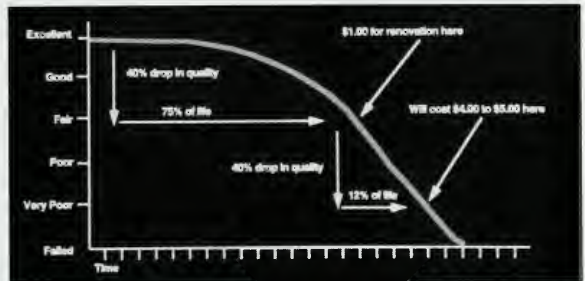
Many building systems are considered by owners in terms of their life cycle cost. The same approach can be used for building exterior elements, so that an owner or facility manager can better assess future maintenance needs and cost. The deterioration curve in this slide has been constructed to show how a building exterior (or elements such as the roof or exterior wall system) deteriorates over time. The condition and time frame is relative, and the shape of the deterioration curve may vary.

The general concept of the curve can be applied to a roof system, exterior wall system, a plaza deck, parking garage, or any other structure exposed to the weather.

Effective facility maintenance on the exterior of a building can accomplish two things: extend the useful life of the exterior and provide the ability to forecast major repair requirements.

Like building mechanical systems, the building exterior requires routine maintenance to prolong the life of the system. Few people would fail to recognize that an automobile requires routine maintenance.

However, not many will recognize building exterior maintenance. Building exterior maintenance is either infrequent or ignored altogether.



Life cycle cost.

EXTERIOR CONSTRUCTION

Roofing:

The primary source of protection from the elements is the building's roof system. Volumes of material have been written and are available regarding the multitude of roof systems available.

The two most common types of roof systems are built up and single ply. There are many other types of roofs such as shingled, metal, tile and others. However, the same principles of proper design, construction and maintenance apply, no matter what the roof type.

Built-up roofing consists of alternating layers of roofing felts, embedded in hot asphalt. The felts are typically made of rolls of asphalt-saturated glass fiber material. These felts are layered in a shingled fashion, generally in three or four layers. The completed felt layers are topped with more hot asphalt, and gravel is embedded in the asphalt. The gravel surface keeps the roof surface from cracking and deteriorating from the effects of the sun and weather. Built-up roofing is typically installed over insulation which is attached to the building's structural deck system.

Single-ply roof systems consist of a "polymetric" membrane sheet material in which a single sheet acts as the primary waterproofing element of the roof. The type and variety of polymers is diverse and ever-changing. Single-ply systems are constructed in one of these ways:

1. Loose-laid and ballasted.
2. Mechanically fastened.
3. Fully adhered.

As with built-up roofs, most single ply membranes are installed over a layer of insulation which is attached to the building's deck system.

Although there are other membrane systems, and many ways of constructing each system, these two primary categories of roofing account for over 80 percent of the commercial roofs installed.

Both exterior maintenance and extension of service life start with good record keeping. Factual data such as the type of roof system, insulation, method of attachment, deck type and warranty, are available when roof problems arise. Roof life can be extended by keeping it clean, keeping drains running freely, and maintaining surfacing, coatings, and sealants.

Many facility managers keep detailed files on different systems in order to gain quick access to information. Detailed files are a necessity because building drawings do not often reflect the level of detail required when assessing building problems. Additionally, systems such as the roof are frequently changed during construction and this information is rarely transferred to the drawings.

Roof systems that are not maintained may only perform for about half of their expected design life. If roofs are considered on a life cycle cost basis, the annual costs of a well-maintained roof is only about one-fifth that of a roof that is not maintained. Even if these figures are considered extreme, the cost benefit ratio of maintaining a roof versus ignoring it is a clear argument for active maintenance.

So how does one go about maintaining a roof? These slides depict a historical record and owner maintenance inspection check list.

The historical record is a convenient data form which indicates general information, specification requirements and records type of single-ply roof systems. This is considered a general data sheet and can be used for quick reference. The OMI checklist is a concise, easy to use form which carries the owner through an inspection, and lists the typical defects found in the roof deck, walls, membrane, flashing, and metal components.

Present condition is recorded, and recommended action such as contacting the manufacturer or roofer is listed. The OMI checklist should be completed at least annually and all data kept safely in the roof system file. Many of the

Roofing Historical Record

General Information

Building: _____

Tenant: _____

Location: _____

Phone: _____

Contact: _____

Specific Information

Construction Type: ☐ New ☐ Tear-Off ☐ Recover

If recover, describe existing system: _____

Roof Deck Concrete: _____ thickness Type: _____

Roof Slope: _____ inch/foot Areas of Inadequate Drainage: ☐ Yes ☐ No

Drainage System: Briefly describe the roof drainage system, including drains, plumbing, scuppers, gutters, downspouts and sumps, if any.

Single-Ply Membrane Thermoset: ☐ CSPE (Hypson) ☐ ECH ☐ EPDM ☐ Neoprene

Inspection Checklist

Inspection Checklist:

Perform an initial general building inspection: condition may indicate roof problem. Note location for investigation on roof.

ITEM CODE	CONDITION PRESENT	ACTION NEEDED	ACTION TAKEN
INTERIOR		rfr = Roofing Contractor	
Roof deck		mfr = Membrane Manufacturer	
A.1	Rusting	Contact rfr/mfr	
A.2	Spalling	Contact rfr/mfr	
A.3	Cracking	Contact rfr/mfr	
A.4	Buckling	Contact rfr/mfr	
A.5	Sagging	Contact rfr/mfr	
A.6	Open Joints	Contact rfr/mfr	

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conditions noted, such as keeping drains running freely and maintaining coatings, coverings, and sealants, can be performed by company personnel.

A similar historical record and checklist is available from the asphalt roof manufacturers (ARMA) and NRCA which covers built-up roof systems. Another detailed method of inspection and maintaining roofs is through the use of a computerized Engineered Management System (EMS) that involves inspecting a roof's membrane, flashing and performing a moisture survey on the insulation. The roof is inspected visually and a quick assessment of the type of defects, their severity level and quantity is made.

The data is entered into a data base, and using other factors such as roof type and age, a numerical rating of the system, or Roof Condition Index (RCI) is developed. If the rating system is used over multiple facilities, or on the same facility over multiple years, the deterioration of the roof system or systems can be pinpointed and prioritized, so the effective repairs can be budgeted and made on a non-emergence basis. EMS is also capable of helping in the decision-making process, providing cost estimates for repair based on unit costs to repair each defect. A repair versus replacement cost ratio is then calculated and a ratio analysis guideline is provided.

Exterior Walls:

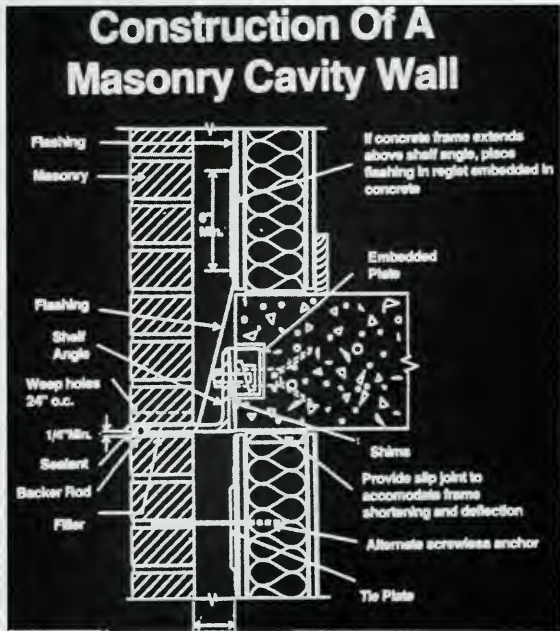
Most modern exterior wall systems are designed and constructed to serve an aesthetic and waterproofing function. With few exceptions, these systems function separately from the building's structural framing system. They are designed to keep the elements out and to move with the structure to provide a barrier to moisture penetration.

Two of the most common exterior wall types are masonry and precast concrete. Others consist of glass, Exterior Insulated Finish Systems (EIFS), stone, metal, or a combination thereof.

In older times, masonry walls were commonly built as a barrier wall type. The double widths of interlocked masonry were integral with the structural framing system of the building. Their construction was thick enough to support the structure from lateral loading and to provide a substantial enough barrier against moisture infiltration. However, from a practical standpoint, this limited the height of a solid masonry structure to only a few stories.

Modern masonry construction is usually of the cavity wall type. It is well known that a substantial amount of water can penetrate an exterior layer of brick and mortar. Once the water penetrates, it must be allowed to drain into the cavity, then out over the flashing and through the weep holes in the exterior of the walls.

The exterior section of brick is supported at each floor level by steel shelf angles that are bolted or welded to the building structural framing. The cavity is designed to be up to two inches in width. Steel reinforcement spans the cavity and ties the brick



back to the building laterally. Flexible sheet flashing is used to span the cavity at the bottom of each wall section and direct any water back to the exterior.

This slide shows a typical precast concrete panel exterior. The concrete panel is fabricated off-site, transported to the structure, and bolted or welded to the exterior at the ends of the floor slab and at columns. The precast panel acts as a direct barrier to water penetration.

Masonry and precast concrete exteriors are just two of the more common exterior elements. Regardless of the type of exterior wall, wall systems also rely on sealants placed in expansion and control joints to resist water penetration. The expansion and control joints are necessary to control cracking in the exterior walls or wall sections due to building movement. The joints are filled with flexible sealants to resist water penetration. The joint must be properly designed and constructed to allow movement and retain flexibility.

Sealants are often used on building exteriors to reduce water penetration. Sealers are composed of different chemical formulations of material which fill microscopic surface and subsurface pores. Sealers are frequently used on masonry and concrete walls. They should not be expected to stop leaks in a building, but are useful in reducing the amount of water which penetrates.

In most cases, it is critical to select a penetrating sealer which "breathes." A breathable sealer is capable of reducing moisture penetration without locking in moisture which can freeze and thaw and create material damage.

Due to the diversity of exterior wall systems and the fact that walls are slightly less leak prone than roof systems, a uniform or generally accepted wall system or EMS has not been developed. As such, facility managers should use the same approach to documenting the history and maintenance of exterior walls.

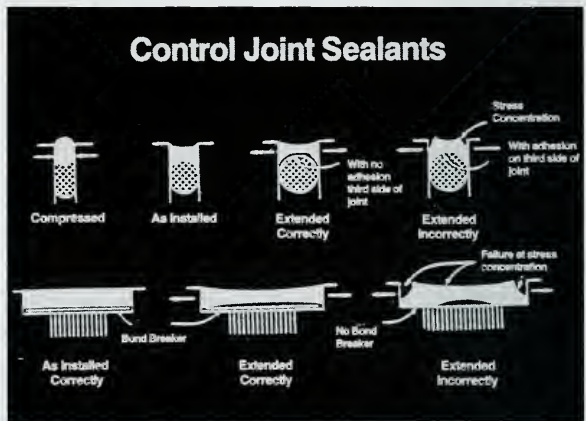
The building exterior checklist has been developed for assessing property condition, but is easily adaptable for use as an annual checklist for exterior walls. The critical factors which owners should note on an annual basis are:

1. Presence and condition of control and expansion joints in the overall wall system.
2. Performance of sealants.
3. Presence of coating or sealer systems.
4. Wall cracking and movement.
5. Discoloration from dirt or pollutants.
6. Presence of dirt or pollutants.

Just as there are operating procedures and manuals associated with heating and air-conditioning systems, there are specific procedures to be followed to operate and maintain roofing and exterior wall systems. There are several key elements to managing these systems:

1. Accountability for the system.
2. Periodic inspection.
3. Record keeping.
4. Budgeting.

Any successful program has clearly defined responsibilities for input and maintenance. In order for the management program to be successful, it also requires a high degree of com-



mitment from the property or facility manager to provide the required training and incentive for maintaining the system.

Periodic inspection on an annual or semi-annual basis is usually sufficient to maintain roofing or exterior wall systems. Documentation of these inspections is critical to maintaining the management systems. The maintenance of “as built” drawings can save hundreds of man hours once a problem is discovered in the roof or wall systems. Warranty information is also critical to properly maintaining the roof or exterior walls. Photographic documentation is relatively inexpensive and can literally save thousands of dollars when roof or exterior wall problems arise.

The budgeting and funding process is also an important part of the management system. Periodic inspections can point out upcoming repair or major replacements, allowing sufficient time to react from a budgetary standpoint.

Aside from the management aspects of a roof or exterior wall management program, there are many physical activities that a building or facility manager can do to extend the life of these systems.

Routine maintenance of roof systems should be performed at least twice a year and should consist of the following:

- 1. Keep the roof clean and free of debris.
- 2. Control traffic.
- 3. Keep drains running freely.
- 4. Maintain coatings and sealants.
- 5. Maintain protective coverings (gravel and ballast).

This slide outlines some typical costs associated with tearing off and reroofing and provides some comparison between maintained and non-maintained roofs.

TABLE 1 – TYPICAL ROOF MAINTENANCE COSTS

Maintaining exterior wall systems follows similar conventions, although the building or facility manager will not be able to provide the same type of routine maintenance with in-house staff due to the difficulties in working on vertical surfaces.

Wall cleaning is also an important maintenance technique. The most effective cleaners are those that are gentlest to the substrate and do not wear away the surface during the cleaning process. Abrasive or acid-wash cleaners should only be used under controlled circumstances and should always be tested prior to being used on a large area.

TABLE 2 – HIGH PERFORMANCE SEALANTS

A critical factor in the maintenance of building exterior systems is that many of the components will not last the life of a structure. Building sealants typically have a service life of about five to ten years. Here is a brief summary of three readily available high performance building sealants:

TABLE 3 – SURFACE COATINGS

TABLE 4 – WATER REPELLENT SEALERS

Building surface coatings and water repellent sealers also have a finite service life. Here are some performance characteristics of typical exterior coatings and sealers.

TABLE 5 – EXTERIOR REPAIR COSTS

This slide shows a general summary of some typical exterior wall repairs and the associated cost.

When water infiltration is not the specific problem, exterior and interior defects of the building skin must be thoroughly documented on elevation and plan drawings in order to evaluate remedial repair options and their related costs.

As with any engineering-related problem, the best solution is one that is functional and economical. When the structural integrity of the building skin is at risk, safety of the building occupants and pedestrian traffic in the vicinity is of prime importance. In situations where

building materials such as masonry units, natural stone veneer, mortar, glass or other objects may be dislodged from the exterior walls, weather resistance and aesthetics take a back seat to the emergency measures required to re-establish a safe condition.

The ultimate goal of any remedial design is to reinstate the major elements of a functional building envelope. It has been my experience that seldom is there one source of a problem contributing to a performance failure in walls and facades. The key to the investigative approach is to isolate the contributing components and resolve them separately. Even then, one should anticipate that 10 to 15 percent of the problem will have to be resolved in a subsequent phase of investigation and remediation.

Considering the variety of architecture, building components and combinations of materials utilized in the building industry today, and the multitude of forces working to cause weathering, distress, and degradation, the building manager must be part engineer, maintenance person, tenant relations specialist, accountant and program manager. Understanding the basic concepts of construction of the building and the methods available to protect its assets goes a long way in changing reactive maintenance activities into a cost-effective proactive maintenance program.

COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM

Computerized maintenance management systems are used to schedule and track preventive maintenance, repairs, and renovation projects. They are often thought of as “upgrades” to many work order systems. In fact, they can and should be utilized for much more. They should be used as financial tools to measure and control productivity of the physical plant operation staff, construction staff, maintenance staff, and contract services.

One of the most common complaints from facilities managers is that they cannot obtain adequate funding for their department to operate and maintain the facilities. Obviously in those situations, their perception of priorities for funding must be conveyed to senior management in a language that management understands. Conversely, corporate management often does not have a clear understanding of what the facilities operations and maintenance staff do. All they seem to understand is financial reports. In a world where “outsourcing” is today’s favorite buzzword, this tool can be used to evaluate that option and control both in-house and outsourced services costs as wells.

CMMS can be used as a financial tool to communicate with corporate management in a language they understand to justify the funding of operations and maintenance.

WHAT IS CMMS?

Computerized maintenance management systems (CMMS) are computer programs designed to manage maintenance and repair operations for a facility. Typically, they have the capability to:

1. Generate work orders for preventive maintenance, repairs, emergency calls, or construction projects.
2. Track the status, completion, cost, and history of these work orders.
3. Track inventory of spare parts, material, tools, et cetera.
4. Track repair/PM history of building systems and equipment.
5. Purchase requisitions/orders.
6. Warranty records.
7. Labor costs.
8. Parts/materials costs.

These programs are usually written with a commercially available database program serving as the platform. They are organized into modules. This slide shows a sample flow diagram illustrating how these modules interact.

Currently there are many of these types of programs on the market. They run on main-frame computers, mini computers, and desktop PCs. Prices range from under \$2,000 to \$50,000 and up. Interestingly, ease of use, features, and capabilities do not necessarily corre-

late with cost or type of computer required. Some of the less expensive (\$3,000 to \$10,000) programs may offer more utility than more expensive programs. Often, they are more flexible and can be more easily adapted to a user's specific requirements.

WHY CMMS?

Let's look at this question from the financial officer's perspective. At one time, all bookkeeping was handled manually. But, with the advent of the affordable PC computer systems, virtually all book-

keeping is performed on computers. Why? Because the computerized database permits analyses of the data in ways that were unimagined in the past, at greatly reduced labor costs. It provides the financial officer with management tools and information which he could not obtain from a manual system.

Let's compare a manual maintenance system with a computerized maintenance management system. Both create and process work orders. Both maintain equipment records. Both create and process purchase orders/requisitions. Both include an inventory control system. What's the difference? The management tools and information reports which are readily available from a CMMS are too time consuming, labor intensive, and costly to obtain from a manual system.

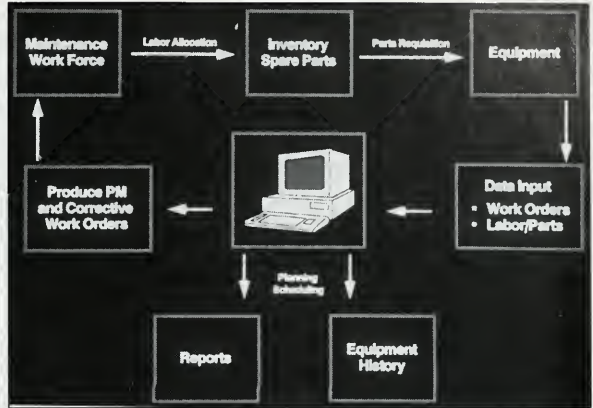
WHO SHOULD BE INVOLVED WITH THE CMMS?

Obviously a computerized maintenance management system should be the province of the maintenance department. Right? Perhaps. Yes, the maintenance department staff will be the people who will have the most contact with the program and will use it most frequently. Without their acceptance and cooperation, the system is doomed to failure. However, they are not the only ones who can benefit from a well-organized and utilized system. The production department, the facility manager, and financial officer can, and should, all have an interest in the system and benefit from it.

The maintenance department typically uses the system to schedule and track work orders for (planned) preventive maintenance, corrective maintenance, emergency repairs, outside contractor's services, and small projects. Their typical concerns include: staffing/schedule, assigning the appropriate personnel to the task, spare parts availability, work order backing, and work order status.

The production department should also have an interest in the system. Planned maintenance usually necessitates shutting down equipment for servicing. By interfacing with the maintenance department and taking advantage of the CMMS, shutdowns can be planned more efficiently for both departments.

The facility manager should have a keen interest in this system. On a broad brush basis, the facility manager knows what the maintenance staff is supposed to do, but usually they have no way of monitoring the staff's effectiveness or productivity. They have no data to justify capital replacement of obsolete equipment which will reduce maintenance costs. When belt tightening is required, they cannot provide hard data to justify staffing levels below which the physical plant will begin to deteriorate due to inadequate maintenance. The ability



Sample flow diagram of modules.

to compare the option of outsourcing certain maintenance functions versus performing those tasks with in-house staff is available with CMMS. The CMMS can and should be the facility manager's equivalent of the computerized bookkeeping system in the accounting department.

HOW DO YOU IMPLEMENT A CMMS?

With many programs to choose from, and with multiple departmental interests to be considered, implementing a CMMS can be a daunting task. While we can't make it easy, we can at least outline the process for implementing an effective CMMS. Frankly, obtaining assistance from a competent consultant can make the process much easier and smoother. Given the potential cost savings and other benefits, the consultant's fee usually pays for itself in just the time difference it would otherwise take to get a CMMS system up and running:

1. Identify goals - Purpose - System Criteria:
 - a. Which departments need to interface with the CMMS: maintenance, purchasing, production, finance, et cetera?
 - b. What types of reports does each department want?
 - c. How should the data be organized? by department, craft, product line, building, et cetera?
 - d. Who needs access to the system: maintenance manager, maintenance staff, purchasing staff, finance staff, facilities manager, et cetera?
 - e. Budget.
 - f. Number of work orders per year.
 - g. Number of pieces of equipment to be tracked.
 - h. System features: Input methods, output methods, networking, et cetera.
2. Identify System - Equipment:

Construct a survey of CMMS software and compare software features to the criteria defined above. Many software manufacturers will provide either live demonstrations, sample software packages, free trials, or other means of evaluating the software. It is important to evaluate the user friendliness of the system, the ease of entering and closing out work orders, and the ability to create/generate the desired reports.

3. Select and purchase software and hardware.
4. Install and test software and hardware.
5. Identify systems and equipment to be tracked by CMMS.
6. Collect nameplate information for each piece of equipment.
7. Develop preventive maintenance procedures.
8. Develop PM schedule.
9. Develop procedures for generating work orders.
10. Begin using CMMS.
11. Develop scheduled reports.
12. Analyze the data.
13. Set goals.

Just like the introduction of computerized bookkeeping revolutionized the world of financial management by providing analytical and control tools that were unavailable before, introducing a CMMS can revolutionize the way facility managers deal with managing the maintenance and operation of their physical plants.

The facility manager can and should set goals related to PM standards, PM budgets, repair budgets, capital replacement budgets, service warranties, staff productivity, et cetera. These budgets can now be based upon detailed hard data which is readily accessible and analyzable. The term TQM (total quality management) has recently become very popular. The concepts presented above follow the philosophy and present a method for implementing that abstract concept.

A computerized maintenance management system is more than just automating an existing manual maintenance schedule. It is a completely new way to manage the operation and

maintenance of a physical plant and its equipment. It can be applied to both small and large facilities cost effectively, and yield substantial benefits both to the company and to the facilities department directly. It can be applied to building systems, production systems, materials handling systems, transportation systems, or any other system of concern to the facilities department.

In conclusion, facility professionals must expand their awareness through education and training. They must become proactive and not reactive in approach. They should take calculated risks. They must become assertive and not aggressive in their management style. They should realize that successful programs are processes and long term in nature. Above all, they must ensure that any safety, health and environmental issues share equal priority with productivity, quality, employee morale, revenue, and costs.

Thank you for your attention. (Applause)

Mr. Van Huis: Thank you, Dick.

Our final presentation today is on confined space which will be given by Alan Misiaszek of Amtrak. Alan is the manager of industrial hygiene with Amtrak. Before that, he was affiliated with A.F. Meyer & Associates as director, national agency and general defense programs division; the Phelps Dodge Corporation, and the Olin Corporation.

Alan is a member of the American Industrial Hygiene Association and the American Academy of Industrial Hygiene. He has also co-authored several publications.

Please join me in welcoming Alan Misiaszek. (Applause)

CONFINED SPACE

Alan Misiaszek

**Manager of Industrial Hygiene
Amtrak**

What I am going to try to talk about today are compliance issues relative to the railroads; however, this is not unique to railroads really. I would like to start by asking you a question. How many of the people here are responsible for people who are going to go into confined spaces? A few of you are. How many of you have been through training programs on confined space? Some of you.

What I am going to go through are some of the issues about confined space relative to OSHA as they apply to the railroads. There was a rumor out a number of years ago that they didn't, but I think most of us understand that they do.

The first point I want to make is, thanks to our government regulators, it's not going to be easy. There are actually three separate regulations covering confined space. Most of the people involved will be covered by the primary one, 1910.146, Permits Required in Confined Spaces. If you have people working in telecommunication applications, there is a different set of regulations and it's a little bit easier than the permit requirements.

The same is true for the electric power generation rules which are new this year. There is not much difference. Fundamentally, you are going to be doing basically the same things.

What makes a space confined? That is the key issue. According to OSHA, there are three fundamental requirements for a confined space. It's large enough and shaped for somebody to get inside and do work. That doesn't mean you have to climb all the way in. Entering a space could be simply putting your head and shoulder through a manhole. That is an entry

under these rules. Only one way in or out or the openings are so small that you can't really get in easily. The space was not designed for continuous human occupancy. It's a machinery space or something else.

What makes a confined space dangerous? This is why we have rules. Things can happen in these spaces. It has or could have a hazardous atmosphere. Oxygen deficiency is responsible for more fatalities in confined spaces than anything else. It's probably 50 percent or more. Toxic or flammable gases or vapors. Hydrogen sulfide and methane are the second leading causes of problems with atmospheric hazards. Work-created hazards such as welding fumes or other things. A lot of people have been killed by painting inside a tank without proper ventilation and other things.

The second thing is it can contain a material that can engulf you such as sand, gravel, or grain. Things can collapse around you, or you can get down into them and you can't get out of, like quick sand. This is the second leading cause of death in confined spaces.

It has an internal shape that can trap or suffocate you. Slide down inside a sand tower that is empty. At first, what is going to happen is you are going to get wedged in there and you won't be able to get out.

Other recommended safety or health hazards. Electricity and water don't mix. Mechanical energy sources, thermal energy sources. There was a fatality case where a fellow was going in to check a steam line and died of asphyxiation because the steam line broke and displaced all the breathable air.

Biological hazards. I get a lot of chuckles out of this one. Sewage, insects, snakes, vermin. I don't know about you guys, but I wouldn't want to find a snake in a hole especially if I couldn't get out too fast.

The whole process of confined space entry and the reason for the regulations is to make a space safe for entry.

Control the atmosphere. The primary control obviously is ventilation. What you try to do is bring air in to flood the space. You completely flood the space to displace the contaminants if possible. You have to test the air continuously for contaminants if you have a source of continual leaks, such as a gas leak or solvent leak. We had a situation outside of Philadelphia where we had a communication manhole that had gasoline in it from an oil refinery. It was an interesting situation.

You must do personal monitoring for things that require gasoline vapors containing benzene. You have to do personal monitoring for that to make sure you don't exceed the other OSHA limits. In some cases, you have to use personal protective equipment up to and including a self-contained breathing apparatus. That is a relatively rare instance, but it is a possibility.

Control the physical hazards. For mechanical or other energy sources, you apply lock out, tag out. One of the things the permit required confine space rules do has triggered a lot of other OSHA requirements like lock out, tag out, blinding, blanking pressure relief of pneumatic hydraulic lines, stream lines, and things like that.

Personal protective equipment, if you have a noisy motor or some other source of noise, if you have sources of heat or cold, if you have potentially live electrical sources down there. If they have electrical insulation blankets. Anything that you have to do to protect the entry of the person going into the space from whatever hazards are recognized is what you have to do. This is all laid out.

We have a relatively extensive compliance program that basically is a series of checks. These are checks that you go through and if you get to a certain point, you can stop. If you keep on going, you have to follow each one of the steps to account for all the hazards.

Standardized entry procedures. Space evaluation and entry check list is critical. Everybody is doing the same thing the same way every time. There are different types of spaces. The rules recognize that in some cases you will only have atmospheric hazards. There is a little bit of ease back on the requirements. You don't have to have a permit for those

kinds of spaces. Our program calls for us to fill out a certificate instead of a permit to check and balance system.

The telecommunications spaces don't require rescue teams, and I will talk about that in a few minutes. In this case because of the nature of what is in those spaces, they don't have the requirements in their standards.

Unrestricted spaces where there is no hazard. Those are very rare. There is always a potential hazard of some kind.

Appropriate training for everybody is critical. You have different classes of individuals that fulfill different roles. In most of the cases within Amtrak, most of the people have taken at least the first three, the entrant, the attendant, and the entry supervisor. The entry supervisor isn't necessarily someone in management. It is the guy who says everybody is ready to go into the space. He is the one who signs the permit and it's a crafted person by and large in many cases.

Rescue team members require extra specialized training. What they are doing is a lot different. It is critical that management and craft receive the same training so that they are talking the same language and saying the same things and understanding the same issues within those spaces.

Then there is Murphy's law — the law of the universe. A problem occurs beyond the ability of the attendant, the guy outside the space must respond and do something. Rescue teams are critical. They have to be well trained. They should drill quarterly.

How many members? It really depends what the space is like. What are the hazards? How many people are in the space? All of this has to be planned in advance. You don't wait for something to happen. It's a real management effort to get these things established. Again, what crafts? If you have electrical sources and you have plumbing down there such as steam lines, you need electricians and you need pipefitters. You need people who know how to deal with those hazards.

Where is the rescue team? Are they standing outside while the entry is going on? Sometimes you have to do that. If you have a particularly severe potential case of hazards they should be right there. The four-minute rule is enacted if you have a situation that can knock somebody down badly. I am talking about shock or something that knocks them out or somebody can stop breathing. You have four minutes to get them out, their heart going, and their breathing restored. After that, basically you are recovering a body.

The nature of the geography. On our northeast corridor between Washington and New York, basically, our management has decided that we assign teams to do entries with rescuers working nearby. If they are within that four-minute rule by truck and they can get to that space, they can go ahead and work until something happens.

There is the whole series of issues about retrieval equipment. It depends on the entries. We have had entries in horizontal furnaces where a vertical tripod didn't do you a lot of good to haul somebody out of that space. They do have what they call horizontal tripods or devices that can drag somebody out of a horizontal space.

You have retrieval equipment. You have first aid medical kits to mobilize people to stabilize them. Trauma control means stop the bleeding. Rescuer personal protective equipment. If you have atmospheric hazards, they all have to be trained and drilled on the use of Scuba, self-contained underwater breathing apparatus.

Craft tools and equipment, again, to address the specific hazards that are present because of the work that is going on in the space. Who decides? This is critical. You have to get management and labor talking and agreeing that this is the right thing to do. This is usually not that hard. They are all reading from the same music and getting the same training.

Thirty-six percent of the fatalities in confined spaces, and I think that's low as I have heard statistics as high as over 50 percent, are people going into spaces to try and rescue somebody else without being properly trained and equipped. That includes firefighters and

emergency response people and that is addressed by this. Ninety-five percent of the local fire department and emergency response teams have not been properly trained for confined space rescues. Those statistics I got from the Philadelphia and New York City fire departments who are properly trained.

What about their colleagues around the country? You can't rely on the local folks to do this. You have to be prepared yourself particularly with the railroad environment where we are out in the middle of nowhere to begin with. We don't know how long it takes these people to get out there.

What else is important? We have always done it this way before. How many times have we heard that? This is one of the hardest habits to break. People don't believe it's really that dangerous just to do these entries. In many cases they are right. But as it becomes part of the natural way of doing business to check first, it doesn't take a lot longer to make sure you are safe.

Test the air, look for other hazards and go. This is another key issue. I have people on Amtrak who are craft people who have been completely trained who are having to argue with some of their bosses because the bosses haven't been through the training. That is a really significant difficulty. I am trying to play labor relations as well as industrial hygiene half the time.

You have to be objective about assessing a lot of things about the spaces. What is a confined space? We have mobile confined spaces on our railroad. We have utility rooms on our superliner equipment that contain air-conditioning systems, and we have switch tanks on board the trains that are confined spaces. Some of the people in our organization don't want to believe that, but it's there.

How is the work done? This is something new. What we have to do is just a little more planning before we start the work and the way we manage the work as well.

Avoid designing new confined spaces if at all possible. Remember the criteria of what makes a confined space. If it's a question of putting a stairway in versus a ladder, put a stairway in. You can walk into a space and walk out. It's not a confined space. It doesn't trigger that criteria.

If you can ventilate a space as well to give you that safeguard of taking out any contamination, that's another good way of doing it. There have been cases where the only reason there was a hazardous atmosphere in a confined space is because the rungs of the ladders were rusting and consumed all the oxygen. People have gone down two or three steps and collapsed because they couldn't breathe.

Training, training, training. Everybody gets training and the same training. Do it on an annual basis. This is what makes your people remember. A lot of times people won't go into spaces very often, maybe only once or twice a year. They forget. A lot of times you learn new things about the way you do business and the way you deal with these things and that helps to reinforce it.

That's basically my presentation. I went a little quickly because I realize we are behind.

Thank you all for your attention. I appreciate the invitation. (Applause)

President Steele: I would like to thank all of you gentlemen for the fine job you have done instructing this afternoon.

We'll reconvene with the Roadmasters tomorrow morning. Don't forget the REMSA reception this evening. (Adjourn)

JOINT SESSION

Wednesday, September 21, 1994

President Steele: Good morning, gentlemen. We have some good presentations and I hope all of you will stay for those this morning.

I trust that you all found the REMSA reception enjoyable last night. Again, we thank these fine folks for not only making our working environment a much better place to be, but we also thank them for their hospitality over the past two and a half days. For those REMSA people in here this morning, I do believe they deserve a round of applause. (Applause)

It appears that we have had a very good attendance at this conference. I thank each of you for your participation and I hope that you will find all of the presentations, committee reports, and workshops very beneficial and something that you can take back home to your office. If you feel you have a need for something that you have seen or heard here today but can't remember the source, please give the office a call and they will guide you to the right person.

Without further ado, I will turn this over to John Van Huis, our program chairman for the first feature this morning.

Mr. Van Huis: Thank you, Don. At this time I would like to introduce Keith Chase, deputy director of aviation and rail freight for the Pennsylvania Department of Transportation.

Mr. Chase oversees the operation of state-owned airports and rail facilities including Harrisburg International Airport and over 100 miles of railroad short lines. He has more than 12 years of diverse experience with the Commonwealth, including working for PennDot's Office of Planning, the Governor's Policy Office, and as assistant chief analyst with the Legislative Budget and Finance Committee.

Mr. Chase is a United States Air Force veteran and served eight years in the Pennsylvania Air National Guard.

He holds degrees from Pennsylvania State University including a Bachelor of Arts in political science and a Master's Degree in public administration. He was awarded the Director's Letter of Distinction for academic excellence for his Master's Degree.

Please join me in welcoming Keith Chase. (Applause)



PENNSYLVANIA CLEARANCE PROJECT

Keith Chase

Pennsylvania Department of Transportation

Thank you, John, and good morning.

The only correction I will make to the introduction that is much appreciated is the title is deputy secretary. The only reason I even stop and make the correction is it's typical of government. It's so great to be in a crowd of private sector where I can criticize the government freely and not have to worry about a federal official or someone telling on me. Typical of government, I have actually been in this job for four years now as deputy secretary for transportation. I was in the job for a year and a half without actually being appointed. It took so long to be appointed because it was an action required by the Governor. Therefore, as long as I am in that position, I am going to covet the title of deputy secretary.

It is a pleasure for me, and I truly mean that, to be here with you. I work in aviation and in rail freight. It's a job that really should be done by more than one person but I enjoy the demands of what has been a real special privilege for me in the past four years in this position. I have enjoyed the opportunity to work very closely with the railroad industry. I want to tell you as a public official that I appreciate the job you do and I salute the job that the rail industry is doing. You are doing nothing less than helping America have a new vision for transportation. The perception lags behind the reality. However, you are just doing an outstanding job and I salute you for it.

The presentation today is on our double-stack initiative. It is somewhat of a generic presentation that we use for a number of different audiences. To some extent, some of the material in here may be old hat. Some will be more for the layman, but what I am going to try to do as I go through the slides is focus more on the things that may be of interest to you.

Although it's not an engineering presentation and I am not an engineer, I hope if I do anything I'll give you a perspective of the importance of the Pennsylvania Rail Clearance

Project with respect to economic development and what made this such an important public project, not just a private project, but what the public benefits are as well.

We were very gratified to see that *Railway Age* did an article in the April edition on the double-stack program. We were very flattered to see the authors of that article really call it a landmark public/private partnership. We think it's a model in some ways. I hope to show you some of the ways and some of the applications that can be used elsewhere.

I am sure you are all familiar with the technology of a double-stack train, which is one container stacked upon another. This is the technology that is driving much of the change in the transportation industry.

I did try to achieve some balance in these photos. Here are some Conrail photos. Unfortunately, I don't have a balanced presentation in terms of photographs as this is the one and only Canadian Pacific shot. That is a CP double-stack train. It is helpful to have that shot in the beginning for people who don't even know what double-stack is to give them the needed visual depiction.

What I would like to go through is a historical background giving you some of the historical context as to the significance of the Pennsylvania Project, why it was needed, the process, how we got to where we are today which is near completion of double-stack service in Pennsylvania, the payoffs, and finally, some of the lessons learned.

First of all, let's talk a little bit about the historical background. I think what transportation professionals, particularly in the public sector, need to get much better at is working with you and meeting your needs. I think what we are learning is we have a transportation system today that was developed mode by mode. In many ways it disconnects. In many ways we have looked at modal solutions rather than looking at transportation solutions. However, I do think we are moving out of that era fortunately.

The historical context here for the double-stack project is we had the railroad boom, of course, in the 1800s. That 1850s infrastructure of the old Pennsylvania Railroad, while it helped our country grow in a major way, represents the 1990s constraints to goods movement in Pennsylvania. Our waterways advanced in the 1800s. In the 1900s our highway system began in modest ways and thus began the mode of carrier penetration into the goods movement segment of our economy. In the 1900s, our airways were developed also. In the 1950s, we saw the construction of the interstate system at which time public policy really tilted towards trucking.

I think then there is a major change and a notable change and not one that is fully on the radar screen of the public in general. But in the 1990s there is a trend in your industry brought about and that is the intermodal era. I emphasize that was private sector. I think in the public sector we normally lagged behind and that's probably good in some ways. But the public sector is just now realizing the significance of the intermodal era of one mode connecting with another as you would define intermodal as a combination of rail or truck in the movement of goods.

What is it that sparked that intermodal era? Well, it was deregulation. It was government getting out of the way. It was containerization which shifted from water to rail and then rail truck. In 1991, the Intermodal Surface Transportation Efficiency Act was passed marking that intermodalism now became the law of the land or public policy.

You know, a lot of things come out of Washington that none of us like. ISTEA, the legislation that governs transportation for Pennsylvania and the United States for the current six-year period, has a lot of things wrong with it. One thing that is right with it, I feel, is that for the first time federal policy recognizes that there is a great industry out there that is significant to our economy. It directs the government at all levels to make sure we are working closely with the freight industry to make sure that things we do, such things as access to rail terminals and so forth and that we know what the problems are and what the corrections are.

There is probably a lot of potential for government getting carried away. It's a two-edged sword. I think in Pennsylvania we are going to do it the right way and make sure that

we don't dictate what your needs are, but that we understand them better and then can deliver a transportation system better integrated with the needs of the railroad industry. The 1992 double-stack project exemplifies that kind of attitude on behalf of a public DOT. It does pre-date ISTEA requirements, but it's a great asset in promoting what is good in ISTEA with that emphasis on the movement of goods and people, not single modal focus.

Here is a little mini picture really of intermodal development. This is a locomotive that dates back 160 years. It was first put into service in 1831.

This is a picture of a Pennsylvania Railroad freight train loaded with 100 cars of coal on the Pennsylvania Railroad. This is the public's mindset I think still to a great degree, that the railroads are quaint and historical, but I think the public perception is a misconception. Many still think railroads are an outdated mode. Many think that railroads are a low technology mode. We know differently. Many believe that railroads are a slow or poor service mode. We know the railroads now through deregulation have turned customer service on its head and are much more focused on the needs of the customer and the requirements of the customer.

Just as a side note, I think I would call you to work with us, all of us together as I think we have an educational challenge to show the public and to prove otherwise some of the misconceptions that still exist about the railroads.

There is a water canal which still is a very highly efficient means of moving goods by barge.

This slide is a favorite. They call this an electric truck. I like to tell our PennDot district engineers that this is what they can expect for their future equipment without any new funding. PennDot highway funding comes through a liquid fuels tax. As you are probably aware, those revenues are very flat. Vehicles are more efficient and people are driving less, therefore, our revenues are flat.

Intermodal transportation, getting back to the theme, is growing for several reasons. You are familiar with a lot of them, so I will just highlight a few. The truck driver shortages are really daunting. The industry has made great efforts at retention, but the half life of a truck driver is about 6 to 12 months. Improving rail economy such as with the double-stacks and the ability to ship goods at more efficient, lower rates and, with that, widespread shipper acceptance of intermodal as customer service has improved.

I was looking at the business section in the Harrisburg Patriot newspaper last Saturday and they showed a stock summary of stocks of local interest for the week. There is a little blurb for each stock and under Conrail, unfortunately, it said for the week that the stock went down \$3. That is normal fluctuation I suppose, but it also had a little caption about the double-stack project. This caption indicated what the growth percentages were in different segments of the business. It showed coal at seven percent and some other products in the seven to nine percent range. Can anyone guess what intermodal showed for the quarter for growth? Twenty-five percent was the quarterly growth for intermodal. It is the explosive segment of the transportation industry. It is even opening the eyes of public officials.

This is the evolution of the rail load hauling envelope ranging from the trailer on the flat car in 1960s to the domestic container high Q car of the 1990s with the clearance requirement of 20 feet 2 inches. You will see in between the auto racks increasingly being used for the shipment of automobiles. Right in the very middle is that fully-enclosed auto rack that provides that high level of customer service and protection of the product that the auto manufacturers are looking for. This is what we are after in Pennsylvania. There is a great emphasis on getting these auto racks into the Port of Philadelphia and there is also a great emphasis on capturing this domestic cargo.

Why was the double-stack project needed anyway? It may be obvious to you, but as public officials, we have to make a case to our 12 million Pennsylvanians. We must inform them as to what the public context is for what they may perceive as a private project. We didn't view this as a private project. Some of the reasons are keeping Pennsylvania competi-

tive in a global economy. If there is anything I am excited about, it's that transportation people are beginning to realize slowly but surely that they play a major role in economics. Anything we can do to lower freight transportation costs and help our economy to stay competitive we need to be going at with full vigor.

One of the things that is coming out of ISTEA is that we start defining performance measures to see how we do intermodally. If we don't define any other performance measures than how our actions help you to lower your costs, it's not even worth the exercise. But we are committed to making sure we can show that we are going after actions that help lower the cost of moving goods.

We want to create and preserve Pennsylvanian jobs. We have an outstanding manufacturing tradition, but it was hit in the 1980s in many Northeastern and Midwestern industrialized states. Still the effort is that manufacturing jobs are really the best jobs. This initiative is important in terms of not only creating but keeping manufacturing jobs in Pennsylvania. It accommodates the intermodal partnership which is the kind of thing I mentioned earlier. In the 1980s this huge trend began and the public sector has a responsibility to adapt to that sea of change taking place in the private sector and making sure that our infrastructure in Pennsylvania is not constraining this important achievement.

It enhances the need for an integrated transportation system as envisioned by ISTEA. We are in the business now of pursuing connectivity as the buzz word versus a formerly isolated modal effort or mode-by-mode activity. Pennsylvania is known as the Keystone State for its strategic location, but being the Keystone State is not necessarily a given, despite fixed geography. If we lose the advantages in terms of changing transportation technology, the Keystone State becomes more of a euphemism for days gone by. This project is important for it maintains that keystone location.

The other need for the project is that we have made a sustained effort for port development. The Port of Philadelphia was in a very poor position in comparison to other east coast ports. There has been a commitment to vastly improve the competitive position. There are now three Class I railroads, Conrail, Canadian Pacific, and CSX, serving that port. There has been intermodal yard expansion. There have been \$50 to \$60 million in other capital investments all aimed at expanding the economic opportunity of that port.

There are probably some geographic contexts as well. Within a 500-mile radius of Harrisburg you have 40 percent of the U.S. population and 60 percent of Canada's population. That's a lot of consumers. You also have 45 percent of the nation's manufacturers shipping and receiving goods and 41 percent of the nation's domestic trade and service industries.

If you remember during the presidential campaign, President Clinton said, "It's the economy, stupid." Our Governor, in taking the leadership on this project, said in a way, "It's the market, stupid." We have to go for the market.

This chart depicts something that we do and that is we build a lot of highway bypasses in Pennsylvania. Sometimes you hear jokes about bypasses that skirt very small towns. This slide shows how we are currently being bypassed with double-stacked service. The line and the cycle diameters at the terminal locations basically approximate the relative volumes of double-stack service and double-stack volume. If you look for the Port of Philadelphia, you will see that it's barely visible yet the other east coast ports have extensive volumes of double-stacks. So we can no longer be bypassed but we must be very much a part of this important transportation development.

If you look to the north, you will see Canada. Canada is important to us. Why? For the markets as I have said. Pennsylvania, several years ago in partnership with the Canadian Pacific Railroad, worked to acquire the bankrupt Delaware and Hudson and the CP Rail System now serves the Port of Philadelphia and serves other points in Pennsylvania. We wanted to be part of that market link to Canada, our number one trading partner.

This chart really answers the question of what Pennsylvania and the railroads have in common. What is the common ground for forging this partnership? As state government, we

care deeply about economic development and the creation of a positive business climate, jobs, transportation excellence, and better utilization of existing transportation capacity. We cannot build our way out of every problem. Railroads or the intermodal industry, in general, care about squeezing out costs and the strategic use of the advantages of each mode, greater profits, adapting the changing markets, and optimizing capital investment.

The one thing I haven't mentioned yet is at the very bottom of what's in common and that's customer service. Together we have a common customer and that is the shippers of Pennsylvania. While this process had room for a lot of differences in terms of competing railroads involved with state government, the point I would like to make is there is a lot of common ground as well. While it wasn't always an easy process hammering out a three-party agreement, including two competitors, this goes to demonstrate that in such projects the key is to find the common ground.

On the customer service aspect with the railroads, Charlie Marshall, who is the vice-president for development of Conrail, mentioned in the days gone by that the truck industry could promise you service within an hour, and the railroad industry might promise you service by August, but don't wait. That has greatly changed. Service is meant to be on time today.

This slide is a work in progress. It is meant to have Conrail's and Canadian Pacific's logos up there as well but that is my favorite state DOT so I didn't remove the slide.

Here is a map showing the routes that are being cleared today. The Canadian Pacific portion goes from Binghamton to Wilksborough and then Canadian Pacific moves on Conrail from Wilksborough down through Allentown, Reading, and then on the Conrail mainline into Philadelphia. The Conrail mainline is shown from Ohio to Philadelphia through points such as Pittsburgh, Johnstown, and Harrisburg.

This slide is already dated because Conrail has initiated new service from Harrisburg south as part of their partnership with Norfolk Southern. The important point is that Pennsylvania now becomes part of a growing network throughout the region as well as throughout the nation.

Well, what are the projects? There were 134 obstacles to clear and here is how they break out. There were 45 tracks to be lowered, 11 tunnels to be modified, 34 bridges to be modified, removed, or raised, 36 signal bridges, and eight projects involving the raising of wires or utility pole crossarms. As of September 15, 79 of the 134 projects are already completed. In the bridge category I would note that while I will be showing you what the general funds were that went into this project, PennDot also accelerated its bridge program wherever it involved a clearance project. Some of these projects were way out into the 10th, 11th, and 12th years of our 12-year program. However, because of the importance of this project, those were accelerated simply to provide the clearance. The project is moving extremely fast and the compressed construction schedule may even mean that the 79 number is higher today than it was as of September 15th.

This is simply a list of some of the partners. We do call it a partnership process. We have a Governor who had a genuine interest and a passion for the project whose leadership has been there several times along the way and even his follow through has been there. We had a trip across the state from Philadelphia to Pittsburgh touring the project with a Governor who went through a heart and liver transplant last year. At Harrisburg when the train stopped, he stood out there in the blazing heat of that day and spoke about how important this project was for Pennsylvania.

Pennsylvania legislators authorized the legislation for this project. In some ways where you have a strong trucking industry you had a strong group against putting public funds into this. I have to give them credit as it was not really an easy vote. The railroads are just a tremendous partner in every way. I think when we look back the double-stack project will be a landmark event for an improved relationship between the state DOT and the railroad in so

many ways. It even played out the following devastating winter that we had in getting salt into Pennsylvania. We worked with Conrail very much in a partnership way on meeting that emergency just like we did with this double-stack project.

PennDot is not just the people in my deputate, but it's people in our district as well who have red flag systems. If there was anything that caused a problem to the progress of this project, they let us know about it.

The Public Utility Commission and the Pennsylvania Historical Museum Commission wouldn't be thought of as being partners. They are regulators and they could stand in the way of timely project completion. We have worked with them to get timely approvals even to the point of establishing a P.U.C. committee and giving them their name. We appealed to the ego, but it worked. We have an expedited process for public utility commission approvals. Municipalities and private landowners aren't partners really in the strictest sense, but we recognize their interest just the same.

For the double-stack funding, Governor Casey's leadership with Pennsylvania legislature approved \$38.1 million for the project. That's general funds. The state funding is capped at that amount meaning that we didn't have to take the same risk the railroads did. If there is an overrun, which there is in any project like this, they are absorbed by the railroads. Conrail is at \$39 million, Canadian Pacific is at \$3.3 million. Out of those 134 projects, only six of them are Canadian Pacific projects. CSX has authorized but they have not yet become a party to the agreement. Another \$3 million is in reserve should CSX become a party to the agreement.

What is little known is that \$1 million was authorized for horizontal clearances to allow for the movement of project cargo, principally liquefied natural gas heat exchangers produced by air products, some of them with diameters up to 17 feet.

After quick legislative action, we established agreements for the horizontal and vertical with Conrail and Canadian Pacific Rail. We didn't have a lot of time to do that. We had only three to four months and the clock was ticking. The Governor charged us with having this project done by December of 1995. He got that same commitment out of Jim Hagen and Rob Ritchie and so we who were involved in negotiations of the detailed agreement worked long and hard. Really how we got there was pure sweat. There were a lot of ugly drafts, but the key was getting the issue on the table and making continued incremental movements.

Construction design was completed in the spring of 1993 and the first construction project began in the summer of 1993. This project will be done in about eight months probably before June of 1995 if not a lot earlier. This shows there is a tremendous commitment to have a total project duration of less than two years.

This depicts one of the 11 tunnels, the Spruce Creek Tunnel near Huntington, Pennsylvania, in central Pennsylvania.

This is the same tunnel photographed this time from the inside. The tunnels were quite a highlight when we had the statewide tour. That statewide tour was very helpful in bringing public interest and public curiosity to the project.

Here you see the steel girder in place that will shortly be encased.

This is another picture inside of the Spruce Creek Tunnel after the blasting and the trimming. The surfaces are being sprayed with shotcrete.

This is an artist's rendition of an 1850 tunnel. It's called the Flat Rock Tunnel in Philadelphia. It is right next to the Scookal Expressway. The Scookal Expressway is the main artery through Philadelphia. This was a very tricky expansion project including having to shut down the Scookal Expressway one or two times. There was tremendous cooperation from our PennDot highway district in the area. Conrail did a marvelous job in terms of community coordination of the blasting project and the traffic portions of it. The expansion of this tunnel is going to include the restoration of the portals to that pre-existing condition or design from the 1850s. It does not look like that today, but it will when the project is complete.

This shows more what it looks like today but it will be restored with the historical interest in mind to the 1850s condition. I think that speaks to the real pride in the project that Conrail has. Even though they are working with the Historic and Museum Commission as a regulator, they appreciate the value of the historical asset that the Pennsylvania Railroad is and the need to preserve and to actually build upon that historical asset. It's about a 150-year-old tunnel and this is only the third or fourth alteration that it has experienced.

This slide simply is an exhibit of a wide range of project costs from a \$15 million tunnel project to a minor bridge modification for \$10,000 to lowering of track which is the most predominant type of project averaging about \$200,000 per site.

What are some of the key features of our three-party agreement? Someone could ask how can two competing railroads and state government ever agree on anything. But we did. Some of the key features are port access that was provided by Conrail and Canadian Pacific. This was the stickiest issue of all. It was the one legislated item. The port interests were able to get this into the authorizing legislation that the secretary of transportation had to certify that port access was provided. With regards to public utility coordination, as I said, we even established a P.U.C. committee to ensure expedited approvals of project work.

Pennsylvania's financial participation was capped. There was a provision for the horizontal clearance. Project sequencing and coordination allowed for a critical path and mutual completion. I think the incremental method of getting there and making constant improvements on that agreement proves you really can negotiate anything.

The completion date is June, 1995, as I noted earlier. It is likely to be done even earlier. The original target was December, 1995. Why? Let me note a few reasons why. Tremendous project management by people like Jeff May and Dave Sans at Conrail and the engineers with CP Rail System. I will take credit for the Commonwealth in that we have an expedient administrator's system that ensured payments and inspection work were on a fast track. We were not the cause for slowing the project.

If there is anything in this that does lend itself to a case study it's regulatory management with the P.U.C. approvals and the historic approvals.

The bottom line really is money and economic incentives of getting this project on-line to realize the financial benefit.

What are some of the double-stack payoffs? I would like to think of this in terms of the public benefits. The understanding of why you would even use public money because this cannot be perceived as simply being a grant to one or two railroads.

Over 22,000 jobs are expected to be created by the year 2000 directly and indirectly including a net increase of 1,200 trucking jobs simply by virtue of an increase in the volume of goods moved and the implications that has for shorthaul trucking. Transportation cost savings may be the most important public benefit. There's an annual \$53 million estimated cost savings for Pennsylvania employers. An analysis was done by our consultants, Transmode Inc., and their economic analysts, Apogee Research of Bethesda, Maryland. A very careful economic analysis showed that the benefit cost ratios are extremely high. You get a payoff in year one in excess of the commonwealth's investment.

This \$53 million estimate may even be low based on the projections at that time versus the traffic that has been realized already and the expected increases.

As an economic development marketing tool, is double-stack a panacea? Will it be the way of the market in Pennsylvania? No, but it is one tool anyway. Some might ask what would have happened if the State didn't put money into this? I think the answer to that is Conrail would have done the project at some point in time, but I think it is safe to say that it probably would have been delayed two years or five years. Would it have been worth it to delay the benefits to our state from an economic development perspective?

Where are the jobs? For 6,600 direct jobs, I point to the year 2000 column. We show an estimated 2,700 new manufacturing jobs were allowed by reinvestment in plant, equipment,

and people. There will be a small amount of railroad jobs. For wholesale and distribution, there will be 2,500 estimated new jobs by the year 2000. Pennsylvania is extremely well situated in this category especially with the nexus of highway and rail interface in places like Carlisle and Harrisburg in central Pennsylvania.

Other payoffs include the port theme that I have been drumming home. We expected a 50 percent increase in time in new container cargo as a result of the double-stacks. This is two years ago when the analysis was done. One year later, before double-stacks were even completed, they saw a 70 percent increase in containerized cargo at the port simply by having three railroads there. That's before the double-stack service even begins. That proved that the estimates were conservative. This will be a major marketing tool for the port as well as to attract new shipping lines and new shipping line service.

I must emphasize, however, that this is not a port project or a pork project for that matter, but it is a project with statewide benefit. The double-stack payoffs also include environmental advantages. There is a report resulting from a study that Conrail commissioned a couple of years ago comparing the cost of Interstate 80 in Pennsylvania to the Conrail mainline and it showed per ton mile and so forth that it is much more environmentally friendly to move by rail. The emissions are lower, and transportation congestion is lower. Conrail every day takes 5,000 trucks off the roads that would have been on Pennsylvanian highways. If you line those up, that would be 50 miles of trucks. We are seeing better use of existing transportation capabilities and infrastructure. Our days of building our way out of problems are over. Plus there are safety benefits, improved land use, and reduced energy consumption. Those are some of the range of public benefits for this project.

I won't go into detail but Conrail has already announced, subsequent to our agreement, major expansions of their terminal facilities showing that based on revised traffic projections, growth will be far more than was ever expected.

I have to tell you as a public official and a state DOT that this project has gone a long way to foster the understanding and appreciation of railroads and intermodalism in what is traditionally a public works or highways setting. I can't overstate the importance of that. While we work with other metropolitan planning organizations on goods movement, this has given people a project to focus on that intermodalism is tangible. It is not just an abstract idea of Washington, DC, and of public policy makers.

Concluding, what are the lessons learned? The importance of involvement of top leadership, public, and private. Governor Casey and others worked with Jim Hagen and Rob Ritchie closely on this. The team concept may sound trite, but it's true. Good communications and follow through and I think a lot of trust was experienced through this effort. This good communications is not only establishing this initiative but at the project level as well. I was extremely pleased with how well Conrail communicated with the communities affected by blasting when they were doing these tunnel projects. They go out in the communities, talk with the people, and make sure that people are prepared. They did good planning for the blasting. It was shown that good communications occurred at every level.

Another lesson learned is the importance of being able to identify, quantify, and communicate the public benefits of the project. I think we are going to have to do that after the fact as well to show that the expected benefits were realized. Building public support and understanding is important.

Seeking the best transportation solutions was another lesson learned. We never assumed that if we built it, they would come. While the project is waiting to go on-line, we have been involved in marketing efforts, putting out brochures, working with the port and others, and attending economic development conferences to make sure people know that there will be double-stack service available.

The most important thing I can tell you today as to why this project worked is government did not see itself as a regulator, but a facilitator. How important that is! We can apply that in so many different ways rather than government always standing in the way.

Another lesson learned is to avoid the strings of public funding. I had to fight a good fight to make sure the legislation did not get saddled with a lot of requirements imposed on the railroads or the agreement. We were under constant pressure, be it from labor, or be it from the port people or others, who were concerned that they weren't going to get what they needed. We were able to keep the agreements basic and the legislation basic that this project would not cave in because of a lot of strings being attached to public funding.

In summary, I truly believe that this is a justified public investment and I care deeply about the taxpayer dollar. There are many beneficiaries, not just one. It's broad based. There is job growth and there is economic development. The name of the game, economically and politically, is can you produce jobs through public expenditures made? A more efficient transportation system for Pennsylvania? After all, the E in ISTEA is efficiency and keeping Pennsylvania competitive. It showed me, as well, through this experience that there is a greater need for private sector and public sector collaboration and transportation planning and programming. I believe we will work closer in years to come in many different areas. Not only work closer, but more constructively.

Our Governor put it well when he called on the legislature to move on this project. He said, "Pennsylvania's double-stack network will be as important to our transportation network of the 1990s as the construction of the interstate highway system in the 1950s." That's the way you paint the vision. He painted the vision very successfully and we look forward to seeing trains like that in the next few months going across Pennsylvania.

Thank you for your time. (Applause)

Mr. Koff: Thank you, Keith. We appreciate you coming down and telling us about what is happening back in your neck of the woods.

Next we have a young guy who is going to talk about equipment. He has been around the industry just for a little while. Vinnie Terrill is going to come forward and tell us what is happening with REMSA and some of the new product lines and equipment.

REMSA PRESENTATION

Vinnie Terrill

**Past President
REMSA**

Some of the items that REMSA is accomplishing include political action, new and expanding roles in industry, communication, research and testing, equipment shows and exhibits, scholarships and education, interassociation cooperation, and networking. We are old, that's my part of it, and we are new.

Asplundh

The Asplundh aqua heat 2,200 gallon vegetation control sprayer uses only hot water to control weeds and grasses. Nothing else is used to control the vegetation other than 210 degree Fahrenheit water.

The area shown in front of the Asplundh aqua heat spray unit shows results two days after receiving a treatment of hot water.

This slide shows a distinct pattern left two days after treatment with the Asplundh aqua heat hot water sprayer. This particular segment of track had not received any treatment in 12 years due to environmental concerns and regulations.

Brandt Road Rail Corporation

The Brandt Road Rail power unit is a versatile intermodal car mover which is capable of pulling up to 15 loaded 100-ton cars. It is seen here moving maintenance-of-way equipment, pulling track evaluation cars over 100 miles on track tests with Canadian Pacific Rail.

CamCar Textron

This slides shows a new 7/8 inch, cam-rail, screw-spike, alloy-steel, heat treated to 150,000 psi and coated by cam coat. The steel heated treated to the 7/8 inch high-strength screw spikes are used for high-tonnage heavy traffic tie plates, base plates, and all severe rail curve applications.

The next two slides will show their new three-quarter inch 120,000 psi grade crossing timber spikes for high speed and high tonnage grade crossings. You will also notice the yellow coating everlube 6110 for corrosion protection, built in lubricant, and reusability.

Chemetron True Temper

The Chemetron True Temper easy throw rotary wheel switch stand is ergonomically designed to be safer and easier to operate than conventional lever-operated stands. Simply depress the foot-operated latch, release the pedal, and rotate the 30-inch diameter wheel one complete revolution. The 17:1 ratio ensures maximum operation safety and minimum lower back stress. It is available in both top and bottom crank models. Easy throw utilizes most existing connecting rods and head block ties and is available with or without sheer pin protection.

David Clark Company

High noise creates a safety hazard for railroads operations. It also interferes with communication between crew members. David Clark Company noise attenuating headsets combine hearing protection with clear communication. Regardless of background noise, noise canceling microphones provide easy to understand transmissions.

The David Clark Company offers a variety of headset systems for use with mobile and portable radios. All offer improved communication and hearing protection.

CXT Incorporated

CXT has developed a scallop-sided concrete tie to help the track structure resist buckling. In-track testing has shown this development to significantly increase the resistance to lateral movement of the tie. The scallop-sided concrete tie is now in regular use on Union Pacific track after test installations on Union Pacific, Burlington Northern, and CSX, where the AAR did the field pull-out test work.

Fairmont Tamper

This is a side view of the Mark IV tamper, Fairmont Tamper's latest addition to its line of production switch tampers.

This is a 3/4 rear view of Mark IV. Here is the computer screen in Mark IV. Computer liner is Fairmont Tamper's latest liner for on-site analysis of rail curvature.

This slide shows desired elevation and best fit for the curve. Through the indication of the distance, the computer calculation that the track will be moved in the top portion of the graph.

TKO2 tie exchanger shows new ties being positioned for insertion from the supply of new ties carried on the TKO2.

HDR Engineering

HDR Engineering was responsible for the layout and design of this intermodal transfer facility in San Bernardino. Layout includes mainline track relocation, curve reduction, new seven track switching yard including the yard lead changes and crossovers as well as strategic plans to maintain mainline traffic and existing intermodal facilities.

Sheridan Avenue in Sheridan, Wyoming, shown here, was designed by HDR. Two new three-span bridges or 2,000 foot long railroad shoe fly, a mainline raise 800 feet reconstruc-

tion and widening of the Avenue all with storm drains and utilities and 400 feet of first rate grade crossing was included.

HDR Engineering designed the CTA link between downtown Chicago and Midway Airport. This half mile section was part on grade and part an aerial structure. They also did extensive station design, railroad retainer embankment, and station platform bridgework.

Hatz Diesel of America

Hatz Diesel of America has met the growing demands for high speed air-cooled diesels that run very quietly. Major railroads have begun using Hatz fully-encapsulated silent pack engines which meet or exceed OSHA's sound standards on railroad track maintenance machines. The silent pack multi-cylinder L series has a power range of 24 to 70 horsepower. Hatz' super single-cylinder diesel engine is also available in a silent-pack version. The sound level from the very quiet running Hatz' engines is lowered another 10 to 12 d/b/a and has a power range from 3 to 15 horsepower.

Geismar

Modern Track Machinery Company's MTX-45-S is Modern Track Machinery's 14-inch abrasive rail saw powered by steel engine. It is fast, powerful, and dependable. Geismar's Pandrol clip applicator can apply two Pandrol clips simultaneously. Geismar's combination grinder provides mill-like finish to surface grinding in frog and diamond areas. Georgetown

Rail Equipment Company

Since 1986, six Class Is have utilized Georgetown's dump trains efficiencies in bridge filling, shoulder enhancement, walkway material placement, sub-ballast, wind rowing, surface ballasting, and wash-out repair. The dump train unloads and places aggregates at rates of up to 2,000 tons per hour. The fully pivotal transfer boom allows precise placement of materials up to 53 feet from center line even in front of itself.

Georgetown's slot machine is an endless gondola capable of off-loading riprap ties, aggregates, and other track materials faster than conventional methods in part due to the Cat 215 track hoe operating from within the cars. Ditch cleaning can also be performed due to the on-board Cat's 25-foot reach.

Hougen Roto Broach Track Star Portable Rail Drills

Hougen's line of rail drills have been ergonomically designed for one-man transport starting at 44 pounds for an efficient one-man operation. The HOK Hougen on wheels demo truck, you call, we go, and their hydraulic model 10928 track star rail drill is working on CSX in Flint, Michigan.

Here is Hougen's electric powered feed model 10924, also working on CSX in Flint, Michigan. Drilling clean, accurately centered holes with no chamfering necessary in as little as 15 seconds in standard RE rail with their patented hydraulic model rail drills has ushered Hougen into the North American maintenance-of-way community.

Hougen has a diverse line of portable rail drills with electric and hydraulic power. The gas powered models will soon be available equipped of course with Hougen's patented roto broach hole cutters. You get up to 500 holes with resharpener. The cutters produce a machine-like finish with reduced heat build up in the hole. Only 25 degrees Fahrenheit above ambient temperatures thereby reducing stress cracking and consequent bolt hole failures. TC

Johnson Company

These slides are of the newest grove worldwide manufacturing 20 ton on and on-off track hi-rail crane product which they are supplying to the North American rail market. The slides are all of the grove model RTR58 which is a 20-ton capacity machine with a fully hydraulic boom that has a maximum reach of 60 feet. Features of these machines include fully computerized load moment indicator systems providing complete load monitoring, load radius, boom angle on outriggers, rubber, and hi-rail. The units easily handle maintenance-of-way support machinery for steel and tie gangs.

The friction drive, hi-rail system provides full transport capability in forward and reverse at 18 miles per hour. The units have available specialized continuous welded rail attachments including dual rail feeder, attachments for the outriggers, and front and rear mounted double flange guide rails.

Kershaw Manufacturing Company

Kershaw's latest in ballast regulators features improved operator comfort, improved visibility, and ease of accessibility for maintenance. The ballast wing has increased carrying capacity of 1 3/4 cubic yards. Hydraulic cylinders are positioned well above the ballast area. Major components of the drive and hydraulic systems are open for easy access and adjustment.

Morback Sales Corporation

Morback's 1,400 tub grinder is the largest model tub grinder manufactured by Morback and is designed for volume reduction of wood waste at rates of up to 100 tons per hour. The Morback model 1,400 tub grinder is capable of grinding railroad ties at rates of 1,200 to 1,500 ties per hour.

Mountain Manufacturing Inc.

This shows a steel gang laying new 1/4 mile stick with a swing loader. Production figures of up to 11 sticks a day have been recorded.

This is a mountain rail ride kit with tie remover, inserter head mounted on a John Deere 310D backhoe inserting tie under the rail. The insertion completed, production figures of 30 ties per hour, 13,500 in one season have been documented.

National Track Work Inc.

Our model number 1100 glidomatic switch stand is a run-through electrically powered with no fluids. It is environmentally sound with 5,600 pounds push and pull. It is furnished with two directional lights and the target with an overload shut off circuit breaker.

Model number 1,200 glidomatic is identical to model 1,100 except this is not a run-through switch stand. Optional remote control capability is available for both stands.

Model 1003 run-through back-saver switch stand and model 1004 manual back-saver switch stand with 45 degrees elevated switch handles, fluorescent painted for night visibility requires only 35 pounds to operate.

Nordco

The Nordco M3 lag screw feeder driver automatically sets and drives lag screws into predrilled ties. The machine is equipped with an adjustable anti-overdrive feature to prevent over tightening and stripping of the ties. The driving mechanism is simple and rugged. Lag screws are fed into the trays by the operator and are loaded into the driving mechanism at the touch of a button. The screws are driven with up to 800 foot pounds of torque.

Truck Bodies by Omaha

Omaha standard line bodies can be engineered to fit any application. The all-galvanized steel body and structural steel under structure makes the line bodies among the toughest in the industry. Omaha Standard stands behind the line bodies with a five-year limited warranty against rust through, hinge, or door lock failure.

Omaha standard Patriot truck bodies is engineered for demanding industrial and general hauling duties. The high performance and low maintenance Patriot is designed to deliver long years of trouble-free service. The Patriot is available in 9'6", 12'6", and 14' models.

Omaha Standard heavy-duty drop side contractor bodies is a durable heavy-duty drop side contractor ideal for commercial operations such as road and building construction, highway maintenance, and landscaping. The drop away sides facilitate the loading and unloading of cargo. The heavy-duty drop side contractor bodies have the heaviest understructure on the market. The double walled, double-acting tailgate is equipped with forward controls and can be used for dumping or spreading operations.

Osmose

Adz pad is a biodegradable tie preservative pad designed to treat the exposed tie plate area during rail relay. The pad is activated by moisture. A slow release glue allows the active ingredient sodium fluoride to penetrate the wood fibers by osmosis. To date, over 22 million pads have been placed.

This adz pads machine was built by ERS. The machine is fully automated and capable of laying pads in either direction. All pads are stapled once placed. Typical production rates are 35 to 40 pads per minute. The automated magazine simplifies loading and placement of adz pads.

Pandrol Inc.

Fast clip is a new fastener developed by Pandrol for use on concrete ties. All fastener components are installed on the concrete tie prior to shipment virtually eliminating component distribution and greatly reducing field labor. Trial installations of fast clip were completed in the summer of 1993 on the Burlington Northern and CSX Transportation on curves of up to six degrees. Additional installations are planned in 1994 on heavy haul freight lines, commuter rail, and high speed passenger service.

Plasser American Corporation

MTW100 is Plasser's cantinary maintenance vehicle. The MTW100 represents a new vehicle concept needed to meet today's cantinary maintenance requirements. Features include it being self propelled at high speeds, having a large self-contained elevating platform, versatile man lift crane, and three room cabin with viewing platform.

RM2000 is Plasser's roadmaster switch and production tamper. Versatility plus describes the roadmaster 2000. High production with outstanding performance for switch lifting, lining, and tamping makes the RM2000 the most productive performer in its field.

Plasser's super stretch in-track flash buck welder. The main characteristic of the K35SSW welder includes the ability to close 10 to 12-inch rail gaps, highest quality welds, automatic particular precision control with three channel recorder, high speed track travel, and internal rail clamping system for rail end alignment.

Portec

This is the roadrunner, the hi-rail lubrication system. The Portec roadrunner hi-rail lubrication system installs to your existing hi-rail vehicle and is available for purchase or contract service. The roadrunner applies grease to the rail through articulating grease nozzles mounted to retractable spring-loaded pneumatic systems that adjust for precise grease speed placement. The grease nozzle activators receive commands from a programmable logical controller, PLC, to shut off grease flow at slow vehicle speeds or when the nozzles are up or when shifted into reverse.

The PLC also provides for preprogrammed or manual grease spraying patterns to the gauge face of the rail. The system operates with dual grease pumps that feed directly from 120-pound grease barrels for easy grease replenishment.

The Power Team

One man, two pumps, and power to spare. In a typical application one man and two power team hydraulic track jacks team up with a power team gasoline engine powered pump for a safe, quick, and easy diamond lift.

Rail Quip

Type GS80 has boom radius up to 70 feet and capacity of 100 ton plus. The crane is diesel hydraulic. The crane travels in transformation at a maximum speed of 75 miles per hour and once there, has a very short rigging time for quick operation. The telescopic boom can lift and travel heavy loads in a horizontal position at a low clearance. The self-propelled speed is 25 miles per hour. It is continuously adjustable with no shifting. The larger cranes may be equipped with a leveling device to allow full lift capacity on super-elevated curves.

A Manisman Demarg Gotweld crane type GS80 carrying track panels up to 45 feet and 30 tons. Higher capacities are available. Manisman Demarg Gotweld crane type GS40 laying track panels. High capacity over the side. The horizontal boom allows operation in tunnels.

RBL Inc.

The industry leader in portable track lubricators, robolube offers a simple, dependable, and compact design in three standards sizes with custom designs available to meet customer requirements. Robo lube's patented design eliminates the need for any air power by utilizing the vehicles own 12-volt system to drive a hydraulic grease pump. This system has proven itself over the past four years with over 100 units now in service throughout the United States.

The grease application nozzles are designed to clear track structure in either forward or reverse. This unique design allows for accurate and consistent grease placement to precisely where and when your operator desires without the need for constant readjustment of the nozzles.

Stanley

Stanley's new grinding and welding tool line. As hydraulics become increasingly more popular with welding departments, Stanley is stepping to the forefront of new technology by incorporating features that make their tools lighter yet more powerful and meet all ANSI and OSHA specifications with cost and pressure switches and internal wheel and stone speed controls.

The Stanley FG10 frog grinder is ideal for grinding frogs, rail end butts, and profiles. On the Stanley TT46 tie tamper, Stanley has taken the lead in ergonomics and safety by incorporating anti-vibration handles into their percussive tools such as tie tampers and spike drivers.

Teleweld

Teleweld now offers a series 1D CWR heater car which uses diesel fuel for heating. This alternative low volatility fuel can be transported anywhere and is readily available at the work site. The car is self-propelled with travel speeds up to 18 miles per hour.

Templeton Kenly Simplex Jack

The power claw's final design is the result of over two years of rigorous field testing and application analysis with track crews throughout the U.S. and Canada. A major factor in the design is operator safety. The power claw was designed specifically to allow one-man operation for lifting heavy loads such as frogs, turnouts, diamonds and concrete tie sections. The low lever bar force, 90 pounds at 10 tons, greatly reduces the risk of back injury.

More importantly, the bar will not kick back and the operator is not at risk of being hit with a bar if it is inadvertently released.

Tie Collar

The subgrade rail support system, the Tie Collar is a dynamic subgrade rail support system which has been employed almost exclusively at highway grade crossings in the Midwest and Southwest regions of the country. However, other potential track applications including curves, bridge approaches, switch leads, turnouts, high speed rail corridors, and diamond intersections fall well within the range of this system's overall capabilities.

The Tie Collar assembly system disperses train loads over a bearing area five times greater than conventional cross tie ballast methods. In addition, its 30-inch diameter base effectively restrains longitudinal and latitudinal forces caused by shifting train loads. Tie collar is a natural in preventing track bed maladies affecting cross ties such as tie rot, skewing, chafing, center binding and plate cutting. It completely eliminates subgrade ballast degradation and ballast bridging between ties.

Moreover, Tie Collar's tough modular iron construction effectively conducts heat buildup along the rails preventing harmful track warping.

Louis M. Tiser Premier Concrete Railroad Crossings

New Burlington Northern crossing using Premier concrete modules serving industrial districts and Port of Seattle container terminals. Premier's heavy rail and industrial crossing installations have given excellent service for more than 20 years. Portland's trimax light rail line is expanding on the City's east side while new westside light rail construction is under way.

Premier is skid resistant and continuous booted rail isolation systems are two key product benefits being incorporated.

Multiple Premier concrete railroad crossing modules were installed nearly ten years ago at Port of Tacoma's facilities. The photo shows Premier's modular system in use in Port of Tacoma's container yards. Premier's history with ports and intermodal yards crossings goes back more than 12 years.

USSC

USSC manufactures an ergonomically-designed seat which incorporates the needs of maintenance-of-way equipment. The 8116 offers 9 1/2 inches with fore/aft adjustment along with a mechanical suspension system which is most advantageous in railway equipment application. Made with high density polyurethane foam and covered with industrial grade vinyl to prolong life in sheltered or unsheltered equipment.

Western-Cullen-Hayes

The FM switch point guard with an adjustable manganese steel wear surface extends switch point life. It can be manufactured to fit most switch plate and brace styles. WH hydraulic pumping posts significantly modified to fit the tracks in Chicago's Northwestern station. WH will dissipate over .5 million pounds of impact. Special units can be manufactured to meet customer requirements.

The electro-hydraulic switch machine is fast-acting, completely trailable at any speed, designed without gears, chains, or clutches. It features an on-board programmable controller.

Western States Supply Company

Their electric hydraulic switch stand, HSS4000 stand concept by Western States Supply Company developed at the request of Burlington Northern Railroad to reduce injuries and as an economical replacement for hand-throw switch stands. It has a low profile of 13 inches with one button operation. It automatically return if full throw is not achieved. Mechanical target shown. Lights available as an option.

Double access to internal assembly. Lift main cover for full maintenance. Lift the small hatch for emergency operations using the hand pump to accomplish the point throw.

Modular format incorporating hydraulic electrical and mechanical components. Simple change out reducing downtime. Accumulator model available utilizing more and steel plunger.

Century Company

Century's full depth concrete grade crossing custom manufactured for a 10-degree curve working through a turnout and out through 10-degree curved track.

The picture depicts panels around switch point and closure rails.

Century's full depth concrete grade crossing custom manufactured for a Number 9 turnout.

The picture depicts panels around frog, guardrails, closure rails, and switch points. Century's full depth concrete grade crossings custom manufactured for Number 9 turnout and 10-degree curved track. The picture depicts tongued switch, et cetera.

We started with REMSA and let's end with REMSA. Thank you. (Applause)

Mr. Koff: Thank you, Vinnie. Our next presenter is Gary Wolf of Rail Sciences, Inc. I met Gary three or four years ago when I was invited to a derailment class in Kansas City. I

thought after 19 years I would have learned how to investigate derailments, but it was the best class I have ever attended. It was very informative and I learned a lot and enjoyed Gary's speaking.

Gary serves as president of Rail Sciences and is the founder. He received a Bachelor of Science degree in electrical engineering from Ohio University in 1971 and a Master's Degree in science and industrial management from Georgia Tech in 1973.

He has attended numerous technical seminars and short courses in the field of train dynamics and rail operations. He started his railroad career in 1970 with the Southern Railway as a student mechanical engineer. From 1973 to 1976, he worked on a variety of mechanically-related projects in industrial engineering. In 1976, he began working with the newly developed track train dynamic simulator model as a senior analyst.

Since that time, he has used these simulation techniques to study thousands of accidents and train dynamic situations. He has also worked at validating the test results in the field. In 1987, he was promoted to manager at Norfolk Southern's operating research department. He is responsible for a wide variety of models dealing with line capacity of locomotive distribution and dispatcher optimization.

Gary is a leader in the industry and has been recognized as such. He has provided numerous papers and reports and we are very glad to have him.

I ask you now to welcome Gary to our conference. (Applause)

DERAILMENT INVESTIGATION FUNDAMENTALS

Gary Wolf

Rail Sciences, Inc.

I, hopefully, have an interesting program for you today. How many of you in the audience are involved in derailment investigation in some way, shape or form? Can I see your hands? A number of you are so you should have an interest in this topic.

What I want to present today are the three basic areas that are track-related issues pertaining to derailment investigation. Obviously, as you know, there are many areas you can get into when it comes to a derailment. Some of you who have been through my seminars that I teach on a number of the railroads around the country may have met me at those times and know that I am a firm believer in multiple causes for derailments.

I found out the hard way, through the last 20 years of dedicating my life to studying derailments, that very rarely is it one singular cause that one has to deal with at a derailment. Yes, there is usually a primary cause without question. But the real issue that we as railroaders have to start dealing with is that there are more multiple causes. I don't care if we talk about train accidents, rail accidents, airplanes, boats, or chemical plant incidents. Anybody in the field of safety knows that when we have an incident you generally have multiple causes.

If you only come away with one thing from my presentation today — if it's that derailment incidents are generally a result of multiple causes; the presentation will have been a success. Often it is necessary to view the interaction between the car body, the car body truck, the rail, and how the other elements interact with these components. We may think that we don't have a FRA track defect and the mechanical guy may say he doesn't have an AAR car defect, so why did it derail? Well, it is often the interaction of the above elements that gets us into trouble.

I know a lot of railroad people in the audience have probably had it beat into their heads for 20 or 30 years that their superiors don't want to hear about multiple causes at derailments. That is true to a large extent on most railroads. I am not saying you go to your boss and say, "It's a little bit of this and a little bit of that and a little bit of this." I am not advocating that position. But I am advocating the fact that we can often identify the primary cause and then certainly come up with two or three other factors that are also at play.

Many times the primary cause is difficult to prevent. But the secondary causes are sometimes very simple to prevent and certainly very cost effective if it saves a derailment. Take one factor out of the pie and one doesn't have a derailment. So keep that in mind in your derailment investigations when looking at possible track issues (which you guys are dealing with) or if you are dealing with car issues or train handling issues. Try to come up with the multiple issues that are surrounding the case.

As Ken said, I have spent most of my career in the area of derailment investigation. Luckily, I have done it from a very objective viewpoint. When I worked at the Southern Railway and then Norfolk Southern, I was in the operation and research group and we could take a fairly objective look at derailments. We weren't really working for the track side or the mechanical side or the transportation side. So it really opened my eyes to this whole issue of multiple causes. I started seeing how all these pieces have to come together for us to have an accident.

Quite frankly, we all have pretty good systems and backup systems out there. A failure in only one area, (for example, marginal track conditions), generally doesn't get us into trouble. But when that marginal freight car comes along or that engineer applies too much dynamic brake, et cetera, and we have a bit of marginal track — that's where we get into trouble.

That's why I am here — to talk a little bit about some of these interaction issues and specifically what I see on the track side that relates to your daily work.

I want to discuss root cause analysis using a few slides, which are generic to the industry. I want to emphasize the importance of scaling away some of the BS in these derailment causes and getting down to the root of what caused it.

Secondly, I am going to talk about some issues relating to curve elevation and cross level in curves. Again I see this coming back to haunt us time and again. We may have some over elevation in curves or cross level variation in curves and, wham, we are on the ground with one of these long tri-level cars. How does that happen? Well, you think to yourself, the track was within FRA standards so why are we on the ground?

Third, I wish to discuss what has turned out to be, in the last year or two, a very controversial area in the industry and that's the issue of this rail rollover business. Some of you may have heard the AAR talk about rail rollover. Really, the controversy involves some practices that we have been doing for a long time. One is rail grinding. Everybody knows rail grinding is a very good thing to do, but if it gets a bit over-aggressive, it can lead to precipitating rail rollover derailments. People, particularly on the track side, are very interested in how this can happen.

Another issue that comes into play in these rail rollover derailments is track lubrication. Many people wonder how can that happen. Lubrication must be good. I want to highlight a little bit of that for you today as well.

What is root cause analysis? It's getting down to the basics. As I said, it's stripping away some of the BS that you sometimes see. If you review the FRA reports in many derailments, the derailment causes that they put in there don't tell you a thing about what caused a derailment. They describe very well what happened. The rail rolled over or excessive slack action occurred. But that doesn't tell you what caused it. That doesn't tell you the bottom line of really what is behind that resulting action.

I would like to call root cause analysis R cubed analysis meaning if you don't get down three layers in a derailment investigation, you are really not doing your job. That's getting

down to first defining what happened. Perhaps a quasi cause will come forth. Then you strip that away to the second layer. Then you finally get down to the third layer. There you are really starting to hit pay dirt in terms of what can be done to correct the problem.

Those first causes that we come up with generally don't lead to fixing the problem. Most derailments, I feel, can be traced back to a human failure in some way, shape, or fashion for a broken rail derailment. People say it's a broken rail. What can we do about that? As you know in the track business there are a lot of things you can do. Were your inspection intervals correct? Did the Sperry car have the right system on it? Were the heads aligned properly? Were you inspecting at the correct intervals for the MGT on that territory? Things like that can influence the probability of detecting broken rails and getting them fixed before they happen.

This slide is an example of what I am talking about. Take the rail rollover as a cause. You get to a derailment site. You see the high rail or low rail rolled over. A lot of people stop right there. Rail rollover is a derailment cause I think on the FRA form and one of the codes that you can use. That's great. You have defined what happened. That is a good description of what happened, but it doesn't tell you what really caused that rail to roll. If you get down to some of the secondary causes that people might come up with, you see things like we had a high buck force or that the old hog head had 800 amps dynamic brake and we can't build a rail structure to hold that kind of force. Maybe we had weak timber. Weak timber is obviously a possible cause for derailments involving timber fastening systems. Maybe we have even identified curve worn rail as one of the issues. That's very possible. I'll show you in a few minutes how curve worn rail can help or precipitate a rail rollover derailment if it gets beyond many of the condemning limits that most of us use — that being a 1/2 inch to 5/8 inch of gauge face wear.

Now let's look at the third level. What caused the high buck force? That could have been a combination of poor train makeup, maybe poor training of the engineer, or perhaps just normal operating practices. Maybe that engineer was trained at Overland Park eight years ago how to handle a grain train, but he hasn't seen a grain train in eight years. Now you give him a 100-car grain train to handle. Off he goes with it and screws up a little bit. You can start stripping away from that high buck force and really get to a root cause.

Look at weak timber. What could be the cause of weak timber? Maybe it's poor drainage, or clogged culverts. Perhaps it's spike kill from respiking the ties in curve worn rail. Again some of the root causes might be lack of inspection or lack of a very good rail replacement program.

The point is strip away and get away from the descriptive causes at the top and even the secondary stuff. Really get into the root cause to get to things that you can fix so you are not out there again in the middle of the night in the rain and sleet picking up a derailment.

As I said earlier, most derailments are rarely caused by one factor. Most derailments do have multiple causes involved. Again, I am not trying to give you a cop out so that you can tell your boss you can't figure it out or even that it's a little bit of this or that. But I think it is incumbent upon us to identify the primary cause and certainly to come up with in any derailment two or three secondary or root causes that are also contributory. As I said, any one of them might be enough to fix the problem and prevent it.

Many root causes boil down to:

1. Inadequate standards. Often if we have good standards, it's a lack of compliance with the standards.
2. Failure to follow standards or,
3. Lack of formal structure to implement standards. Again, that gets back to the human factor side.

Frequently, we on the track side, have a very thick book of maintenance-of-way standards; which is great. But sometimes, perhaps, we slip up and don't follow even the standards

that we have. One should continually compare his standards vis-a-vis against the industry. These kinds of meetings are great for doing that. Look at best practices. What are the other guys doing out there? Do your standards meet the industry standards in most ways? Then sometimes it is just lack of a formal structure. There are standards, but there isn't the structure for implementing them or maintaining compliance. This is what most of the root causes eventually boil down to. When you scrape away all the BS and all the phraseology, you get down to these three basic issues.

Now, let's get to something that might interest you a little more and that's some of the curve issues relating to cross level and super elevation in curves. These are some of the topics that I find coming up time and again in curve related derailments. The first is that most railroads elevate their curves somewhere between one and two inches on balance. Anybody still elevating at equilibrium here on passenger operations? Is that kind of the standard where most of you fall? What is the reason for doing that? Why do we elevate to one to two inches on balance?

The reason we underelevate a track or unbalance it is to accommodate slower speed trains. Just because a timetable says it's a 60 mile an hour railroad, a 115-car coal train isn't going to go up that mountain at 60 miles an hour. So we compensate for that. You guys learned early on to take a little elevation out of the curve to keep things at a happy medium. That is a very good practice. I do find curves that are overelevated are often the ones that seem to have the rock off and rail climb type derailments.

Now, one of the ways that you can look for curves that may be overelevated is to look at the low rail. With a low rail that has become corrugated, battered, or heavily spalled on the running surface, you will see much pitting and cracking on the running surface. That is a pretty good barometer that the curve may be overelevated. In other words, these symptoms are caused by high contact stresses. That's coming about because more of the vertical weight is being thrust upon the low rail. And instead of the rail seeing a 30,000 pound wheel load, the low rail is loaded by 38,000, 40,000, or 42,000 pounds at times; hence the crushing and the spalling of the low rail.

Simultaneous to the application of the additional vertical loading of the low rail is the reduction of vertical loading applied to the high rail. A few extra inches of elevation results in a reduction of 5 to 10 kips of base loading on the high rail. Along comes a car with some instability or a bit of rocking yielding wheel lift and off it comes. That's why I see many derailments happen in curves with too much superelevation.

Now, superelevation must be based on typical operating speeds. I say typical, and I emphasize that, because often we balance a curve on timetable speed. The timetable says 50 or 60 and that's what we set our elevation at. But we have to think what are the typical trains really operating at over this territory? If you are on an ascending grade of .5 percent, you are going to find a predominance of trains are down in the 35 miles an hour regime and not at the 50 or 55 miles an hour regime. So take a look at what real speeds actually are. Ask your operating people. Pull some speed tapes or do your own track side investigation. Be sure you are setting your curve elevations to operating speeds and not necessarily timetable speeds.

The other thing that often gets one in trouble is bunching up against the curve's speed restriction. Consider a 30 mile an hour curve in the middle of a 55 mile an hour territory with additional adjacent curvature. Trains are going to be decelerating for that mile or two preceding the 30 mph curve. Rather than running at 55 mph through the adjacent territory, they are probably operating through those curves at 35 mph. Or if they are coming out of that curve, they are going to be accelerating. Just because the timetable says the speed limit starts at 55 at the end of this curve, I wouldn't think about elevating those additional curves for 55 mph.

Although if you are running commuters and passenger trains or equipment that can accelerate quickly, certainly take this factor into account. Another point is to watch out for uphill versus downhill speeds. Obviously if you penalize the downhill trains, you might run

into line capacity issues. If we have a piece of railroad on a .8 or .9 percent grade and it is a 50 mile an hour railroad by timetable speed, you know those uphill trains may not be doing 55 miles an hour. Take a look again at what the uphill trains are doing, what the downhill trains are doing, and try to come up with a happy medium.

On the railroads that I work with, we have the operating boys, believe it or not, adjust their speed limits to penalize the downhill train five or ten miles an hour. This gives you guys a bit of a break on maintaining your track to an elevation that you can live with day in and day out. That's a real tough order for the track guys to have to deal with — a downhill train at 45 and an uphill train at 20. That puts you between a rock and a hard place in setting elevations. I suggest you work with your operating guys to try to get the speed limits mitigated where you fall into a happy medium. That will minimize your derailment potential.

We talked about how overelevation primarily causes a loss of vertical load because it throws more of the weight on the low rail and reduces wheel load off the high rail. Any little bounce that comes along (i.e., dips in the low rail. I say dips, but they could be low joints, could be soft spots, or a little bit of mud pumping), makes wheel lift more prone. As you all know, water tends to run downhill. Mud tends to accumulate on the low rail of the curve especially in cuts where drainage might be questionable. Soft spots appear there. Many people call it vertical track modulus. The track gets a little soft, trains start beating it down and these little dips and undulations appear in the low rail.

Over elevation of the high rail in curves produces a lower vertical track modulus in the low rail side because of the higher contact stresses to which the rail and ultimately the track structure is subjected. This beats that low rail down until we need the welders in there. These low areas initiate rocking action.

Again, because of being overelevated, you are behind the eight ball when it comes to wheel loads. Especially look out for harmonic patterns. Watch for mud areas and low rail on curves that seem to fit a kind of harmonic pattern when doing your inspections. These patterns tend to match up with the harmonic patterns of the car springs. That's when these rock and roll situations occur. Yes, they may not be FRA condemnable defects. The cross level may not qualify for an FRA defect, but if it is in a harmonic pattern and the right car combination comes along, off she climbs.

When we do our derailment investigation, we see these dips or perturbations, these outward thrusts and downward thrusts of the rail sections. I know many track guys lay out their stations after a derailment pretty much in sync with 15 1/2 foot stations. A lot of the old wise roadmasters will see a dip and say, "Let's start our stationing right here." So then they take the next one at the designated interval. Well, they missed this low spot here. You go out there and look at it and wonder why didn't it show up on the track profile. Well, it wasn't a station. It's one of the tricks they play. I find time and again after doing a simulation on a derailment from which we can't come up with anything. We go out and actually look at the track and find that there are low spots that we didn't pick up on the cross level measurements. These are the things that cause our cars to get into some funny motions.

This is a low rail of a curve. You can see how it is flattened out in sections. Again, this is one of those telltale signs that indicate there may be overelevation in a curve and there may be some rocking and rolling going on.

Here is a case that I found quite interesting. A few years ago, we had jointed rail territory. To orient you, I've provided a chart of the elevation of the curve in inches versus the stations. I think everybody in the room is familiar with 15 1/2 foot stations for laying out profile after a derailment. The train is coming from this direction (right to left). Station zero is our point of derailment. We have the various cross level measurements that were taken. Some were taken on the day of the derailment with no load. A few days later, we had another series of measurements taken. These have been plotted. There are some daily differences between loaded and unloaded profiles and the time that it was taken; but pretty much it is following a

pattern. It doesn't look too bad if you look at it. It's nominally a four-inch elevated curve, but we have a little bit of variation. Look at the pattern.

Here are some little red bars. They indicate areas that I identified as mud pumping through a series of two or three ties in a row where we had significant mud problems. Notice how the mud problems correspond to some of the cross level deviations. In other words, where high cross level existed, it usually corresponds to a low spot on the low rail. It's usually not the high rail going up. It's usually the low rail going down that causes these high cross levels. Notice also the points of high cross level and how they correspond to the mud pumping areas.

We modeled this track using the new car model — the vehicle dynamics model. We simulated low spots in the areas corresponding to the track variation. This represents the simulation work we can do these days to really get a handle on how a given car will perform over a given piece of track. Twenty years ago, we didn't have these kinds of tools. But today we have simulation models where we can take a given car and simulate say a covered hopper with tight side bearings on the A end, and with a wedge rise on the B end, and with a funny wheel profile. We can simulate all of these parameters. We can take the track with this given cross level, with this alignment problem, with this curve problem, or whatever it is; and simulate that track and that car on that track at the speed at which it derailed to see how it performed.

We have done a new car simulation and the only thing I will show you is this is the vertical wheel load on the trailing truck that derailed. Notice as the car entered into this track section, the car rocked back and forth and the vertical wheel loads were swinging from about 20,000 to 30,000 pounds.

Look what happens at the point of derailment. It occurred at a pretty low spot where the vertical wheel loads dropped down to about 15 kips. At the point of derailment, the L/V ratio increased significantly as well. So we pinpointed exactly how track cross level can have an influence on vertical wheel loads.

In my view, these track cross level perturbations were not FRA defects. But it turned out this particular car that derailed had a twist in the car and had some tight side bearings on one end. We came up with that being the primary cause. However, I am trying to illustrate how some minor track fluctuations can take the marginal car and put it in the ditch.

Here we see a case with the side bearing clearances measured to model the same vertical wheel loads. At the point of derailment, you see they are dropping down to a minimum right here and obviously the L/V ratio is doing the same thing. We can determine the critical speed for this particular curve by plotting speed against the L/V ratio. You can see for the speed range between 15 miles an hour to 35 miles an hour, the maximum level of L/V ratio occurs at about 23 miles an hour. Maybe some of you have seen these types of studies for the critical rocking speed for a car. You have probably heard it range somewhere from 15 to 25 miles an hour and that's true for the most part. It is always important to look at the individual car and its truck spacing and the type of springs. Was it D3 or D5? How was that influenced by the track perturbations? We found here that the critical speed was right at 23 and lo and behold the train was operating dead on 23 miles an hour. So we had that particular combination. We had the right speed, the right car, at the right point in the track, and there it went.

Here, we have a loaded coal train coming into a curve and I have plotted the actual curve ordinate measurements represented by the little asterisk line. We can see that it is nominally about a five degree curve. We are entering into the spiral. The other line with the little dots on it is the actual cross level of the curve. Notice on the spiral for this particular curve that it was just borderline as being an FRA alignment change in elevation defect for this class of track. It's right in the spiral, which is a critical region.

We did some simulations on this derailment. We started at 10 miles an hour, because we weren't sure of the speed of this train. We wanted to see if there was a critical rocking speed

for this particular car on this curve. So we started phasing through all the speed ranges. We started out at 10 and went all the way to 30. We did a series of these and found out that when we got down to about 15 or 14 miles an hour, things started going unstable on us. These are plots of vertical wheel loads. They are fairly stable at other speeds and then all of a sudden we get down here and we start hitting the number. That was the speed that the train was operating at. Once again, we were able to predict that particular car on that particular low spot. We also identified on that car a side bearing clearance issue.

Again, I want to show you folks that sometimes these little marginal track problems will be found by the marginal freight car and off we go calling in Hulcher and our cranes. This was an interesting one because the curve had 3 1/4 inches nominal superelevation in it. We found out that the curve should have had about an inch of superelevation. This gets back to overelevating the curve. I am not saying three inches was wrong. You could legally have three inches in that curve. But that wasn't the curve these trains would operate.

Here's a branchline going into a power plant. For this situation, it is a bit unusual to elevate at 3 1/4 inches. When we elevated the curve at one inch elevation, the wheel loads remained about 12,000 pounds. Obviously at 12,000 pounds, we aren't going to have a rock-off situation. At 3 1/4 inches we have an L/V of over 1.5. Many of you in the audience know that L/V ratios are a good barometer of wheel climb or wheel lift. When we did it with the one inch we kept about 12,000 pounds. Although we have rocking motion, we were able to keep a moderate fairly heavy wheel load at the point of derailment. We didn't lose that wheel and we didn't rock the car off. Again, it showed that dropping that elevation on that curve would have prevented this derailment. Obviously fixing the car would also have prevented the derailment. The problem is you guys are building the track structure out there and planning a little bit for the cars that come along that may not be exactly up to snuff all the time. That's certainly reality.

A final suggestion. Whenever you do have a derailment, I think it's very important to plot out track cross level and ordinate measurements and take a look at them visually. Everybody fills these forms out. You have all seen them. CSX, Norfolk Southern, Union Pacific, all have these forms with 20 stations down the left-hand side. You put in all the little numbers. I don't know about you guys, but I can look at numbers all day and really not see a pattern. If you plot them out on a simple piece of graph paper or if you are fancy enough to put them in a computer spreadsheet and plot them out, the patterns often jump right out. Also place the car on the cross level notes with the wheel spacing as it was, whether it's a 66-foot truck center or a 40-foot truck center, et cetera. Put it on there at the point of derailment. Look to see if twist or cross level variation could be occurring on the car.

As I mentioned earlier, it's always a good idea to pick up these mud areas and things when you are doing your station measurements. It may not fall on station two, but if between station two and three a mud hole or a really low joint exists, pick that one up and try to get those situations fixed.

I'll finish up with low rail rollover. Low rail rollover has become a very controversial issue in our industry. There has been a lot of talk in the last year or two about low rail rollover. We seem to be having a lot of these. This summer we had four of them out west that I was involved with and maybe some of you know of even more. Because of the extremely dry summer out in California, Oregon, Nevada, and those areas, we came up with four low rail rollover derailments. Yes, I think they are related to the weather. They seem to occur in the hot, dry months and I'll get into the reasoning behind this in a minute.

There are things that we can do to prevent these derailments though. The four areas I want to talk about are:

1. Track fixation.
2. Loss of steering of the truck.
3. Warped truck conditions.

4. How wheel rail profiles and grinding patterns influence a propensity for having these rail rollover derailments.

We seem to miss some of the low rail rollover derailments because you go to the derailment site and after the low rail rolls typically the high rail goes, too. Out at the derailment site, you see both rails spread and laid over. The conclusion automatically drawn is the high rail went because the highest forces are on the high rail and that's always the one that will roll first. But if you really start looking at some of these rollover derailments, I think you will find that it's the low rail that precipitated or started the derailment and then the high rail followed. Get down on your hands and knees and look for where that first drop mark is on the web of your rail. See if it's not the low rail side.

With track fixation issues we have a couple things to discuss. Spike kill is obviously one. To be honest with you, when the rail starts to roll, the spikes don't really add a whole lot, but they are our last line of defense. The primary thing that keeps rail from rolling is weight on the rail. The vertical wheel load is what keeps the rail in place. We can run a railroad without spikes if we wanted because the weight on the rail is what keeps it in place. Once we start moving that weight around and once we cant the rail; then the spikes, our clips, or our fasteners become the last line of defense. It is shown that they can contribute several thousand pounds of positive vertical hold down. If the spikes are good and are well anchored in the timber, they can keep that rail in place.

Many of you might have encountered raised spikes after they work their way out of the spike holes due to spike killing. Sometimes if ballast is left up high, it will work up under the head of the spike and work it up. Our studies show after as little as $1/2$ to $3/4$ of an inch of spike lift, you have lost vertical hold down. It's gone. It's worthless. If you let that rail cant that much, it's going to pull the spike out. So it's important to have those spikes down firmly against the base of the rail with maybe $1/16$ th of an inch breathing room. But certainly, if the spikes get up $1/2$ an inch or more, they have theoretically lost their holding ability and you have rail rollover.

With regards to differential plate cutting, many of you know on the high rail and low rail you will get more cutting to the field side of your plate. Sometimes as you start to cant that plate you predispose that rail to roll over. You set it up in a geometry pattern where it is easier to flop over. Some of you guys out on the western regions in the Mojave Desert, might have seen the same phenomena with sand building up under your rail base. I have heard of ice in Canada building up under the base of the rail; thereby canting the rail which predisposes it to rail rollover.

Rail section can influence rail rollover. We found that one pattern that seems to show up in rail rollover is the 119-pound pattern. I don't think it has high usage. But it's a high section with a $5\ 1/2$ inch base. Obviously considering the balancing of forces, the greater leverage lateral loads get, the easier it is to roll the rail.

Lastly, we'll discuss premium fasteners. I have never seen a rail rollover on premium fasteners and we have done a lot of research. Obviously some of you know about the double-stack derailments that have occurred in our country over the last three or four years. We have never had a double-stack roll the rail on Pandrol clips, or McKays. It is always wood tie cut spike construction. A lot of railroads have gone to premium fasteners and clips and different types of things on their curves of five or six degrees or more. Seemingly they are having great luck.

The old cut spike is not a bad thing but with the wheel loads that we are running now from 125-ton cars (and we are looking at 300,000 pound load cars), I am not sure the cut spike is going to make it in the future. We have to start looking at some premium fastener systems and concrete ties, et cetera.

Here is your typical raised spike obviously caused by the split tie and it has worked its way up. We have raised spikes on both the outside and inside of this curve. If you are on your

track patrols out there and you see these raised spike conditions, plug them and get them back down.

This is the low rail on a double-stack route. I am going to show you how the low rail is the rail that is more likely to roll in a curve than the high rail. Many of you are sitting there asking what I just said. It's the low rail that is more susceptible to roll over than the high rail. There are higher forces canting that low rail than there are on the high rail. These forces on curves like this one will be able to pull those spikes up. Once the spikes are up about half an inch, they are gone. They are not going to do much.

Again, if this condition is found, get them plugged, get them fixed, and maybe even go to a premium fastener if needed. Obviously with spike kill condition or a rotted tie, the tie is no good and it is not going to let that spike do its job. Plate cutting, differential movement or evidence of plate movement in a rail rollover derailment is key evidence of spike kill. Those spikes have lost their grip on the wood fiber and are moving around in there.

How about loss of steering? This gets down to grinding and gauge face lube issues. What is loss of steering? As you know, when a wheel traverses a curve, something is going to happen for that wheel to steer. In real simple terms, the high side of the wheel must get a little fatter than the low side if you want to steer it around the curve. That's why a wheel is tapered. If you push it through the fat part of the radius or the root of the wheel flange on the high side, you move it out to the low side on the field side of the low rail and that creates a fatter diameter on the high rail and a skinny diameter on the low rail. That wheel will steer itself around the curve.

A great example of the above is to take a tapered styrofoam coffee cup and push it on the carpet. It will go in a natural circle because of the difference in diameters. That's what the wheel has to do.

On the high side of the curve we want to get a fat radius and a low radius on the low side of the curve. This combination of torques will act to steer that truck around the curve.

What basically occurs when we take this difference in radius? The way we achieve steering is to get a point of contact somewhere in the route of the flange where we create a large diameter on the high side. If we come along with either excessive gauge corner grinding or hollow worn wheels; we come up with what is called two point contact. Each of the above situations can cause this condition. You can't generate wheel radius differential with two point contact. The wheel is rolling on a big radius at this point, but that can't support much vertical load so it's basically ineffective.

Out here, we are on a fairly small radius. So when two-point wheel contact occurs, the truck doesn't steer. It sits there and sees that it has two different radii and hunches down and doesn't steer. This causes the trucks to go into the warp mode and create the gauge spreading forces. The truck is warped coming through the curve, consequently it's causing the gauge to spread on both sides. Now a lot of rail guys say they want two point contact because they don't want to have shelling on the high rail of the curve. They don't want TDs to form. That's very noble. No problem with that. But a number of railroads have found that you can grind rail and achieve a single point of contact but yet still spread out the loads such that contact stresses are minimized. We can almost have our cake and eat it too with judicious grinding practices. A number of folks have taken this approach. It is controversial among the track guys whether or not to cut the gauge corner heavily. I think both sides have their valid points. However, we do know that excessive gauge corner grinding leads to two point contact and can get one into trouble by precipitating the rail rollover.

The other primary cause of two point contact is a hollow worn wheel. You can get wheel profiles that hollow out. Compare this to a new wheel profile with a nice taper.

We had a derailment this spring out west. It was obvious we had two point contact and the rail had just been ground the week before. Everyone thought it was caused by rail grinding. No, it wasn't. When we really looked at the match up, it was the wheels that were hollow

worn. The rail was ground exactly the way it should have been. I supported the grinding pattern 100 percent. It was the wheel that caused the loss of contact pattern. It was very significantly a hollow worn wheel. So it can go both ways.

Here's another example of two point contact. We have a point of vertical contact here and a point of contact here and again no contact between. This means that the wheel can't roll on this radius to generate the necessary steering.

Here's an example of what I am talking about. Here's the high rail of a curve. This is the gauge face. Look at this grinding pattern that has left no wheel contact in this region at all. This rail obviously was involved in a derailment. We also can see the familiar metal lip and flow on the edge of the gauge face.

Another indication that the wheels aren't steering is heavy flow on the gauge face of the rail. Look up here, and see that we are not getting much wear. Those wheels aren't steering. When they don't steer, we get that heavy gauge contact or flange face contact. We start to peel that metal right off the face of the rail.

In this situation, we had wheel contact up in here and wheel contact down here but nothing right where we want it. I will agree with you, that rail isn't going to develop TDs, but we are not going to get any steering either. In the long run I think one will have more problems with this situation.

The other factor I mentioned was truck warping. Normally, we want a wheel truck set to go around the curve in a nominally radial position. However, without steering, the truck will get into this warped condition. Both wheel sets lead and trail, take a high angle of attack and create very high gauge spreading forces on both the high rail and, very importantly, on the low rail.

Some of the things that also cause warp trucks on the mechanical side is dry center bowl, tight side bearings, lack of warp restraint, high wedge rise and hollow worn wheels. These are some of the things your mechanical brothers should be looking for on these rollover derailments.

Let's face it, if you get a 100-car train coming through a curve, only one car is going to cause the rail to roll. We have to start looking at that car as to why that car rolled the rail and why the other 99 came through okay. I bet if you start looking you are going to find some of these symptoms on it.

Wheel/rail profiles is another issue to be discussed today. Heavy curve worn rail is more susceptible to rollover because heavy curve worn rail moves the vertical load point further and further to the field side. The further over the vertical load point moves, the less influence that the vertical load has to prevent the rail from rolling. We see this frequently in rail rollover derailments. It's often the rail right at the changeout limits. Sometimes they have the new rail laying there in the ditch ready to go in.

Field side contact on the low rail is an issue in a dry low rail condition. Look at what happens on the high rail of the curve. Hopefully you get a point of contact in here somewhere. That's good. No problem. That generates an L/V, but it takes an L/V of about .6 to roll over the rail. Look what happens on the field side of the low rail. Because we are flanging, we tend to pull the field side wheel, the low rail wheel off of the gauge corner, and we get contact points away from the gauge corner.

The required L/V for rollover on this particular rail was .36. Therein lies the rub, fellows. Everybody thinks it takes a .7 or .8 L/V to roll the rail. But looks what it takes on the low rail: .36 or .4. Therefore, the low rail is more susceptible to roll out than the high rail. This is simply because we are not putting a vertical load on the gauge face on the low side. We are putting it out on the field side somewhere. Think about what happens when we get an old hollow worn wheel coming along with what is called a false flange. That is riding way out here somewhere. I have seen where the L/V can drop to as low as .3 to cause rollover.

Here's an example of what I am talking about. On the high rail, the wheel is typically flanging which is good and the vertical forces act to hold the rail in place. On the low rail

though, with a hollow worn wheel, we are getting contact way out on the field side. When that wheel flange is pulled away from the gauge corner, we have also moved vertical load contact significantly. When we start looking at the vector relationships, we see that this is not where we want the vertical load because it is not very effective in holding the rail and preventing it from rolling.

Here's a case we just recently investigated. We had vertical contact way up from the gauge corner and we had obvious two point contact. The required L/V dropped down to .48 in this case. Again, everybody thinks it takes an L/V of .6 to cause rollover. But for this rail, the rail rolled at an L/V of .48 because of its heavy gauge face wear.

Here's another example where we had vertical forces. Look at the high rail. Look at the wear pattern. This is right on the condemning limit. We had the vertical forces way out here instead of back towards this region. So what it means is those forces are passing very close to the base and they don't add much as far as a restraining moment or a torque in preventing that rail from rolling out. That's why heavy gauge face wear on the high side of the curve often precipitates a rollover situation. Extremely dry low rail is also a factor. Look at all the little metal flakes. That's another good sign that the wheels aren't curving too well. You have probably seen this on some of your heavy MGT routes. For that matter, there is often a lot of metal flaking on both the high and low rails.

The last issue I want to address is a very critical one. This is the one that has everybody scratching their heads. It is very important to maintain good lubrication on the low rail of curves. I know, we are all conditioned to lube the high rail. We all have our oilers on the high rail to protect it. The high rail is the rail we are always changing. But our research has shown that we need to put double-bladed lubricators out there. We must get some lube down on that low rail surface. Why? These gauge spreading forces are obviously acting on both rails. Just a little bit of lubricant on the low rail will almost entirely mitigate these gauge spreading forces. You still may have the warped truck conditions, but it's not going to cause the rail to cant, because it can't creep and it can't make that contact force because of the lubricant. Essentially, the wheel will slip around the low rail. It won't be causing that high force and that high scratching noise as well.

Examine your rail. Get out there and walk real close to the ball of the low rail. Often we'll see sideways scratch marks where the trucks are traversing around the curve and they are canting that rail outwards. And then that rail pops back under load. It will cause a lateral scratch mark on the head of the rail. Normally you see longitudinal marks on the low rail. Look for the lateral scratching marks. They are very distinguishable if you get down very close. That is a sign that you need some lubricant on the low rail. If you have that fish scale, that real dry condition on the low rail, by all means get out there with a hi-rail vehicle. Be sure you are dropping a bit of lube on the gauge corner of the low rail as well. It is difficult to lubricate the low rail because the wheel flanges don't contact, so it doesn't carry too well. But just a little bit of lubricant on that low rail will go a long way towards preventing a rollover derailment.

Thank you for your time.

Mr. Koff: Gary, I would like to thank you for coming down and giving this presentation. You are a tremendous speaker and we really appreciate it. (Applause)

Mr. Van Huis: Our next presentation is on structural steel painting regulations given by Steve Powell.

Stephen Powell began his environmental career as a 1978 graduate of the United States Army's nuclear biological and chemical warfare school located at the Aberdeen Proving Ground in Maryland. Mr. Powell was assigned as an unconventional warfare decontamination specialist and later as an overall advisor for operations in and around battlefield contaminants dispensed via Warsaw Pact nations and terrorist activities.

Upon honorable discharge from the military, Steve began his civilian career as an environmental consultant and project design manager on such projects as asbestos abatement at

Amtrak's Penn Station in New York. He has been involved in the design and implementation of response actions for a variety of Federal superfund cleanups; design of search and testing protocols for imploded chemical munitions at military facilities undergoing closures; design and implementation of lead paint removal and air monitoring at Amtrak's Hell Gate Bridge span and air testing of World Trade Center's Towers One and Two for reoccupancy purposes after terrorist activity a couple of years ago.

Please join me in welcoming Stephen Powell. (Applause)

STRUCTURAL STEEL PAINTING REGULATIONS

Stephen Powell

Environmental Monitoring & Consulting Associates

Good morning, everyone. First let me begin by offering my condolences to you and your industry. You are currently under assault from the environmental regulatory nut cases in Washington again just when everyone thought that they had gotten by asbestos. About ten years went by and they were relatively quiet so it occurred to someone to regulate the hell out of lead — a substance that has been around since man's early existence.

The first thing we are going to address is the origin of the current crisis and outdated work practices. Lead is potentially dangerous to those individuals performing steel repairs when it comes to welding or scraping small amounts of paint off the bridge in order to get a clean weld or cut. But as far as standard work practices regarding your gangs, that would be the only real opportunity that I would be aware of that they could be exposed to this material.

The bureaucratic over regulation portion, the EPA, in their infinite wisdom gave us Title 10. It's always overkill with those people. They came in with a giant hammer and they slammed down all these regulations without giving any thought to the ramifications on the different industries. If you are feeling a little bit bad about what is coming for the lead paint, I can assure you that everyone in the residential real estate management business is even in a worse boat than you fellows. They are unloading buildings at an amazing rate because this will all be in law in about a year.

These are old regulations that they have updated and that's why I love to compare them to asbestos. This is all about the time when they started getting concerned about asbestos. Then a couple years went by and they were having fun with that and then it occurred to them, hey, let's get them with the lead. Now, what they are going to do is tell you that you cannot emit lead into the environment, you cannot emit lead into the soil, or into the ambient air, but they are not going to give you any specific standards as to how much or how little or when you are wrong or when you are right.

At this point there are no federal regulations concerning soil quality so theoretically the lead that has been scraped from a bridge accidentally falling through the air is illegal. However, once it is on the soil, there's no cleanup criteria for how clean is clean and you are only liable while it is falling to the ground.

There are a lot of headlines such as children breathing in lead dust, toxic paint peeling off bridges, or poison playground close to public. It goes on and on. Except for that part where it says pair convicted of hazardous dumping, that is not something you want your firm associated with. The problem of course with the media is they will take pot shots at you first. You may be storing it somewhere and by the time it gets to these folks that write the newspa-

pers it has turned into hazardous dumping or whatever it is they are writing about that day to sell a few more papers.

What I am getting at is that you want to go into your projects very, very visibly. You want to notify all of the people in and around your project what you will be doing. If you have one house within 30 miles of this structure you are considering repainting, you have the potential for a public relations problem because; of course, everyone looks at the railroads as Mr. Deep Pockets. The greatest difficulty is proving it's not from your structure.

We deal with people who call me and say, "Steve, your bridge is killing us. That work is killing us. My kid can't breathe." We go on over to the house and there are paint chips from 30 years of painting the house all around the house. You go around the interior of the home to do an inspection and there all the lead chewable surfaces have been chewed by children. When that gets to court, who is to say where that lead came from. Did it come from your job-site or did it come from the inside of their house? That poor jury is going to be on the violins and it is not going to be looking good for you fellows. What I am getting at here is the litigation prevention aspects in my opinion are probably the most critical initial activity going into any project.

New regulations include Title 10, Lead Exposure Reduction Act, OSHA, EPA, and HUD. This whole thing was generally designed to keep low income families and their children from being exposed to lead in residential project settings. On page 39 column B, someone threw in structural steel. I don't even think they gave any thought at all to the implications of what it was they were about to do. I am convinced that they didn't.

OSHA 29 1926 62, lead in construction, was mandated and final standard issued May 1993. The Resource Conservation Recovery Act is not a brand new law but what it is essentially saying is that from now on all industrial applications or activities are going to focus towards the reuse and reclamation wherever possible of all materials requiring special handling of waste. This is where you have to be very careful with your contractor. I am not a painting removal contractor. I perform air monitoring design specifications and things of that nature.

There are two things I want to send away with you today that can help your company immediately. One would be that the federal government made a mistake. If you have lead-coated scrap steel, you can't take it to the landfills. A lot will accept it, they are not supposed to. But if you were to take all the steel and put it in a bin and take it to a recycling facility, that's fine. It's completely legal to take tons of lead-coated structural steel to a recycling facility. It's absolutely legal and no one can say anything to you. I would encourage you to expedite that process because the EPA is aware of the loophole that they have left and they are working on closing it. It will be open for only about another year.

Case history with the state DOT, lead paints and abrasives, violations, citations. Turning the big bucks for your contractor and consequently for you if you can't complete the job because many of these fines, as you can see, are enough to shut a fellow right off the site. In the coming years, the National Ambient Air Quality Standards are all expected to be implemented. Right now if you are performing a project in any residential location ideally you are not supposed to exceed 1.5 micrograms per cubic meter of air. A typical inside abatement with just hand scraping is in the hundreds of micrograms. That is a rule that was designed for stack testing. Someone called and asked the EPA for guidance, they turned around and yanked out the smoke stack regulation criteria for lead and there it is. It was developed for batteries and smelters. It can definitely be exceeded in a big way on removal projects. As I have been talking all along, the EPA guidelines are unclear and definitely ambiguous. They will tell you one thing, swear to another, and put nothing in writing. So be very careful when dealing with those people.

Air quality with particulates. The PM10 monitor is very poor, however, it's going to be required. You are going to see the monitor PM10. It is really a very poor monitoring device for lead paint removal projects. The device was actually designed for monitoring whole cities

at a time and it wasn't designed for being put near the bridge while you are removing lead point. It was actually designed for being placed all across the five boroughs of New York to determine whether or not there was an infiltration of one contaminant or the other.

Soil qualities for lead. These are typical numbers. Everyone's soil in almost every state has a background level of about 16 PPM. As a result of leaded fuel and its use for just so long, it constantly drifted down through the ambient air and onto all the soils so of course it's going to be much higher near highways and 5,000 PPM from your bridge paint removal unprotected and that's exactly what we are trying to stay away from here.

Cleanup activities have 500 to 1,000 parts per million, but those are HUD guidelines. We are talking about soil that is acceptable for children to be on in their opinion. Then EPA has something planned soon. We just don't know what kind of criteria they are going to have other than don't do it.

Case history is the tri-boroughs. These are average parts per million lead just by taking ground scrapings in the general areas. They are quite high as you can see. The OSHA regulations are applicable to your personnel but, hopefully, the primary responsibility of your painting contractor. Let me stress that it's much simpler to get a painting contractor and then get him to move into an environmental mode than it is to get an environmental contractor and try to move him into a painting mode. It just doesn't work.

Permissible exposure levels have been identified. The action level triggered use of personal protective equipment. There always has to be the presumption of exposure. You have to assume that the exposure is going to take place. You can't think that under the circumstances I don't believe it's going to happen. You have to assume it is. If someone gets exposed as a result of your lack of assumption, they will definitely see you in court.

Competent person responsibilities is a very key thing for everyone to remember. You want to designate that contractor as a competent person. Who is this individual? You need someone to be the responsible party for the activities on this jobsite so that you have someone answerable on a weekly basis about this and that.

Hygiene facilities are essentially decon, respirators and equipment.

Worker medical surveillance and monitoring. To show you just how wildly this has taken off in some directions, under New York City regulations, if a worker's blood lead level exceeds a certain number, he is sent home and he must be maintained on his company's payroll at full rate while they do what is called chelation which is a leaching of the blood for lack of a better term. These guys are home eating bowls of paint chips to stay on this and get full pay for as long as it takes. I thought I had heard it all until I heard that.

Worker training and hazards communication. Please note the scope of 1926.62. All construction where an employee can reasonably be expected to be exposed to lead of any type, your actual exposure levels of 30 micrograms per cubic meter institutes the use of your protective equipment. The permissible exposure limit in an eight hour day is 50 micrograms per cubic meter which was recently reduced as a result of Title 10's activities from 200. Bear in mind that these are eight hour averages so if the men are working 12 or 15-hour shifts or something like that, that has to be taken into account.

Back to our competent person, presumed exposures, for example, sample occupational tasks. Those are the kinds of numbers that will be experienced inside of a work area typically for those types of cleaning. When we are saying manual, we mean power tools and scrapers and things of that nature.

I have seen 25,000 PPM in abrasive blasting units and that's not unusual at all. Some people argue with me on that. If they never place the monitors in the correct positions they always come out low. Methods of compliance clearly specify during the early planning phases of the project, your engineering controls are your first line of defense. You don't want to think you are going to make sure the men are okay because we spent thousands of dollars on all this wonderful protective equipment. When you are under the intent of Title 10, you have to build a work area with a very good airflow and good shower units and rely on as many

engineering controls as possible. Then think about how you are going to protect the men. There are different protection factors for the different respirators available.

I am not going to elaborate on hygiene facilities and practices because you almost have to hold a gun to a contractor to get him to do most of this stuff except for smoking in the work area.

Worker medical surveillance and removal requirements was what I was getting at with these fellows eating the bowls of lead paint chips. It's the law that the contractor perform monitoring or that your men perform monitoring if they are in a position where they may, in fact, be exposed to any type of lead exposure.

Any individual who could be exposed to more than the action level must be trained. There are the expected costs of compliance. OSHA, of course, has one opinion and we have another. The full impact of the OSHA regulation hit in 1994 and they are targeting bridges and water towers. They have specifically been targeted and it occurred to OSHA that this type of enforcement could be a wonderful revenue enhancement source for their organization as a result of many of the cutbacks that they have experienced. So you don't have people so much on-site interested in health and safety as you do wanting to write a big ticket because they think they might get a prorated paycheck out of it.

OSHA is coming out and giving tremendous fines. Regarding the Ohio citation, there is a huge difference between the willful violation and a serious violation. This is all very easy stuff to comply with.

At first glance you think it's a pain in the butt. But if you take a look at it, it's not that difficult to comply with. Title 10 added two toxic substance control acts, that means they can really come out and hammer you legally. Training and certification requirements will be required as well as environmental compliance standards. Training and certification will be required for your contractors and any of those individuals. The time frame for the final rules will take up to 1997. You have to have as many activities completed by 1997 as you possibly can in this country because they are going to go crazy with this. I just know they are.

Other environmental standards include the Clean Water Act and Highway Safe Soils. I think it is such a treat that an agency with those kinds of resources and environmental equipment and laboratories can't make simple determinations as to what soil quality should be.

There will be an impact on owners such as responsibility for hiring, training in-house crews, and increased cost for contractor training, better enforcement, state peculiarities. They vary from state to state. You call Ohio and call New York and ask them the same questions and see what happens. The state enforcement agencies are mainly your departments of health. Sometimes, like in the northeast, we have so many environmental agencies already in place we are just tossing the lead regulations at them now and saying, "Make some money with this one."

How well is it enforced? It's enforced very ambiguously and oftentimes they come out with their opinion which is the greatest outrage. Your state enforcement and oftentimes your Federal enforcement people have a very high turnover rate in both of those types of organizations. They tend to hire very young people who are fresh out of college and they are just dying to show you their badge. They will come running all around your jobsite and start writing violations based on their opinion of what they believe is going on as opposed to what the actual law says. If you get one of these folks out on your site and all of a sudden there are a bunch of violations, make sure you have these violations reviewed by an environmental consultant and compared directly to the law. You will find that probably 70 to 90 percent of it was this fellow's opinion and not what is actually black and white in the regulation.

There are a few other restrictions including volatile organic compounds and silica sand. Stay away from sandblasting of course. They are already beginning to look at zinc as a recrue metal. Try to stay away from it wherever possible in your painting applications because it's going to be the new lead about four years down the road.

Maintenance strategies include spot repair over coats, auxiliary painting, full removal, and repainting and steel replacement.

Overcoating material essentially gets at putting out fires and covering them up with whatever is available so that it will last another few years. How good a strategy that is, I don't know. It's quite arguable. As far as your environmental safety concerns, 1926 62 applicability of course follows to your firm's environmental controls containment, side tarps, ground covers, steel replacement, and environmental safety covers all your demolition workers. Watch out for handling of hazardous material. Scrap steel is not hazardous waste. It's important like I mentioned before to remember that it is not hazardous waste if it's going to a reclamation center, not a landfill, but a licensed reclamation center for steel.

Typical costs for your overcoat full removal and replaced steel, additional costs due to the lead, environmental protection containment, monitoring, disposal, enhanced worker protection, additional overhead, training regulatory awareness, added paperwork, and, of course insurance all add up. The numbers, as near as we can tell to what costs distribution will be before removal can be found in that booklet I spoke of earlier.

Prequalifying your contractor is very important and this gets back to you don't want environmental people trying to do paint work. It's much simpler to get your painting folks operating in an environmental mode.

Attitude towards clients is important. I have friends in the commercial real estate industry and residential real estate industry and they are really taking a beating with this lead situation as well as any of the railroads are. We can't let that jade us towards remembering that it is the law. You are really looking for trouble from these people if you don't comply. They are out in force looking at structural steel lead removal programs and they are coming.

I am a member of SSPC. I am not a tremendous flag waver of theirs, but if you are not a member, go get yourself a membership for SSPC because they are really a good group of fellows who are very knowledgeable in many of these aspects. The most wonderful thing they do is send you a quarterly or monthly magazine, the JCP&L Journal. It's the only magazine I have ever seen that actually has something interesting and new in each issue regarding many of these lead issues as they come up.

Contractor skills, cleaning, painting, condition assessment, quality control, rehab work, environmental and public protection, worker and family protection is where we are getting into. Like as in the asbestos days, where the fellow has been scraping paint all day, he doesn't properly decontaminate, goes home, and all of a sudden there is lead dust in his house. We are not going to talk about the whole interior of his house was painted with lead paint. We are just going to talk about that he didn't properly decontaminate and that's your fault and the onus is on you to prove that didn't happen. This is getting back to that competent person making sure he has documentation that these individuals are, in fact, properly decontaminating before leaving the jobsite.

There are a variety of lead removal and structural steel owners using SSPC certified contractors. What to expect in the next few years in regards to technological development includes regulatory evolution, training and certification, practice costs and disposal insights. Disposal is very interesting because it can change the definition of what constitutes something as being hazardous waste and when something is not hazardous waste.

Reduction in lead CCLP levels for hazardous waste determination is going to have a tremendous impact on everyone because right now they are saying five parts per million after CCLP testing is the cut off for it to be classified as hazardous waste to go to the dump and they are going to lower that still. It's going to be a difficult process for us all.

The states are ahead of the EPA in many cases in implementing regulations. There are few qualified providers. There are very few contractors large enough to supply these types of services in a grand scale such as many of your bridges are.

What is being done? You need to start attacking these regulations through organizations such as this and speaking out. Of course we don't want to spread lead particles all over the

planet, but on the other hand, lead is a very heavy element and we have done a tremendous amount of testing and lead is nothing like asbestos. It doesn't fly away for ten miles. It pretty much drops in the very near vicinity of the work area.

Regarding SSPC standards, what I am going to do is I have a booklet outside and if you will put your name and telephone number in there where I can get a hold of your mailing address, we intend to send you about a three-inch copy of all the pertinent regulations as well as the SSPC standards for designing of these helpful containments to help you accomplish your goals.

There is our Hell Gate Bridge. Here is a classic example of public relations. There is no lead paint left on the top of that bridge. That bridge hasn't been painted in approximately 30 to 40 years and if you were to go up there, which I have many times, all you would find is rusted steel. But the people of Astoria, Queens, were convinced that everything we were doing involved death up there for sure for them and all of their loved ones so we went as far as putting up containments to catch the rust. From a public relations standpoint, it calmed everyone down and they more or less went away. All of our air monitoring determines that we were right in that assumption that there is no lead flying off that bridge. If there were, it would fall into the East River.

Regarding fall protection nets, what I am trying to stress here is the simplicity of the installation of this containment.

This is George Campbell Painting out of Queens, Long Island City. He is a very cooperative fellow, and he is preparing to roll this tarp out. As you can see, he has his fall protection nets strung on these 1/4 inch cables that are strung in place generally in less than two shifts and this is the viaduct leading up to the Hell Gate Bridge. He has cables running up top side. All we are talking about doing is putting in a scaffold system and running cables. I can't stress enough that this is so simple. It's simple to apply. It will only get out of hand if you allow the painting contractor to let it get out of hand. He is placing these polypropylene tarps up there and sliding them across to come up with something like this. It's really very simple.

Here is another example of that one being done. It takes a half hour to slide those across and you have yourself another full containment work area for hand scraping, but not sand blasting.

That little dot up there is an air-monitoring pump. We monitor the air in and around there all day long. This is a bottom view of the containment. This is more of that bridge. This is testing in someone's backyard to ensure litigation prevention so you stay out of jail. Don't let anyone come out to perform your litigation prevention testing by grabbing a handful of dirt and running away. There are proper protocols to follow or it is not going to hold up in court. You want to perform this soil sampling. It is not optional. If you don't after the project, you can never say what it was before.

For street sweeping sampling from a local sidewalk in that area, we used photo documentation just to show the general area where it came from.

The regulation and information packages that I was going to bring here were quite heavy so if you will be kind enough to drop a business card or sign that book, we are going to send you out some present regulations as well as upcoming regulations and things pertaining to that.

Thank you very much for your time. (Applause)

Mr. Van Huis: Stephen, again, we apologize for rushing you through this. We thank you for your fine presentation.

Our next presenter is Al Terry, senior vice-president for Rapid Engineering, Inc., Comstock Park, Michigan. Al is responsible for rapid air management equipment. He has spent 19 years in the commercial marketing and management of the equipment. They have systems of industrial and commercial applications in the United States, England, and Canada.

Please welcome Al Terry.

INDUSTRIAL AIR QUALITY AND ENERGY FOR HEATING AND VENTILATION

Al Terry
Rapid Engineering

It is interesting to listen to things about lead and clean air because that is basically what is sweeping through all industry today. As a company that deals with air management within buildings, this has become a very critical part of what we deal with.

I am going to go through some of this quite rapidly because a lot of it is detail. In the back of the room, there is a complete list of everything that I am talking about in the order that I am going through the slides.

We manufacture an air handler and this is what they look like. It's just a tiny thing. This is a small one, 3,000 CFM approximately and here is a 100,000 cubic foot per minute air handler. Within that air handler we have the capability of a fan that moves the air, you have a burner section, which is an inline direct fire burner and you have a mixing air handler just below that. This allows you to have a variable heat input and a variable air input into your building space.

Let me preface this by saying that normally we deal with fairly large spaces. This space right here would be quite a small space for our type of equipment. Normally we are at about 20,000 square feet or 15,000 square feet up to one million, two million, three million square foot buildings. We normally work in buildings with ceilings that are 18 to 30 to 35 feet or 100 feet high. You will see why this system works so well for what we are talking about here. You have a variable input 25 to one turned on burner which tempers the air which is going into the space and variable air capability between the two dampers proceed to change the rate of the outside air going into the space.

The variable burner gives you variable input because your heat loss is always variable. The air is variable going into your building because the air requirements in the building are almost always variable. No matter what may be said in their design when they fix a design, it makes the assumption that nothing changes, temperature, wind velocity and things that go on in a building.

The biggest problem that we have had in our industry is this burner because this is an open flame. The air goes across that. It is tempered and it goes into the space to be heated and naturally you get all the contaminants that come out of that burner. Let's take a look at what actually comes out of it. It's a 25 to one turn down ratio. Each one of these areas, which is six inches across, has a maximum output of about 250,000 BTU, which means that you have quite a wide range from this minimum fire position up to a maximum fire range. You can see it's a nice clean burning gas flame and the design criteria requires that this profile, the air coming through there across the burner travels approximately 3,000 feet per minute. That's what gets you nice clean combustion which also gives you minimum contamination. There are allowable contaminant levels and you heard the speaker prior to this talk about threshold limits value which is an eight hour exposure for a work day for a work year on the average not to exceed carbon monoxide 50. This goes down all the way to carbon dioxide 5,000 parts per million. Now, that is a nationally accepted standard in every state. Some states can regulate down below that obviously, but that is the nationally accepted standard. That's allowable.

If you look at what is put out by the burner for CO, you can see your allowed 50 parts. The min max output is below six parts per million. So it is really low. The same thing for nitrogen dioxide. You are allowed three parts per million and you can see that the actual output is very low compared to that. It sort of stands to reason that it can't be too big a problem

because this equipment and this type of burner have been in operation now for over 50 years. Our company has been in business for over 32 years and we have never had a liability case and we have never had to go to court to do anything about contaminants. We have done an enormous amount of buildings and so has our industry. I don't know of anybody in the industry that has had a problem from contaminants. There is a very good reason for that other than the fact that they are low.

One of the byproducts of combustion is water. If you put water into buildings that are working on steel for maintenance or welding they get a little concerned. However, the peculiarity of this type of burner says that when you put the burner on you expand the air so even with the water from combustion, you always lower the relative humidity from outside to inside. If it's zero degrees at saturation outside, you raise it to 70 degrees temperature with that inline burner. You get a six percent relative humidity with the water from combustion and you get 15 percent.

At 65 degrees outside at a saturation if you raise it to 70 you would be at 84 percent relative humidity and with the water from combustion it's at 84.5 percent. As long as the burner is on, outside air passing over it, going into the space, the space inside will be lower humidity than the outside.

Now, we have utilized this in our company with our BBC control system for steel warehouses to actually, in the summertime, put this on and raise the temperature to drop the humidity level to prevent rusting of steel coils and that type of equipment. It works very successfully. You really need to have an area that doesn't have a lot of people in it because you do take an 80 or 85 degree day and you raise it a couple of degrees inside. But it is the lowest cost method that you can possibly have for dehumidifying an area.

Carbon dioxide is a direct line function of temperature rise and you can see that as you get up to 100 degree temperature, it gives you 2,100 parts and you are allowed 5,000. There are a couple of standards put out by ANSI, 83.4 and 18 to cover this type of equipment. This standard is tested by ATA and all the equipment industry today does have that label in one form or another.

Let's take a look at the actual reason why this system works so well for us. You have a building outside and you pass air over it. As air passes around the building it creates eddies just like river rafts going down a river. Along a shore, you can actually float up the river because the current goes up due to the eddies that happen. The same thing happens with buildings with air. That is nothing more or less than a pressure difference. We do know what makes air move. Air is going to move from high pressure to low pressure. That's what makes air move and nothing else. If you blow air on a building, we have a high pressure side and a low pressure side, this results in a demand on that building for heat and control that most systems don't recognize.

This is a two million square foot General Motors building. The yellow line is the border loading average for the day during the month of February. The green line is the average daily temperature. If you look over to the right, as the green line goes up, it's because the temperature is dropping. As the temperature is dropping, the demand for heat should be higher and out to equal the yellow line, but you can see the green line and yellow are not really very well related. Then you throw in the blue line which is the average wind velocity for Grand Rapid's Airport and you are now looking at something that actually has little more correlation than temperature. But the two of them combined wouldn't equal the demand for heat.

By the way, the border loading is for heat only in the plant. There has to be some other activity going on here otherwise something isn't working right. Obviously, there are two things missing in this. One is internal heat gain. In any kind of manufacturing process work, you have internal heat gain with whatever you are working with so that's going to reduce the load. You also have mechanical exhaust which is a major issue in industry. For some reason there is a concept that says it is okay to exhaust 65 degree air at 10,000 CFM outside because it doesn't cost me anything rather than heat it and bring it in.

If you think about that you can see why exhaust fans have had such a wide play because they think it's for nothing, but there is a law and it is very specific and it says that you can't put air into a building without an equal amount of air leaving the building. You can't take air out of the building without an equal amount of air coming into the building. At some point very quickly there is going to be a balance reached and you can't defeat that. It is not a space-ship. You can't have those kinds of pressures.

We have a very small brand new building. It had a 50,000 cubic feet per minute unit sitting on top of it. The process that this 50,000 cubic feet of air was supposed to supply by the air handler wasn't even hooked up and a contractor turned it on to see if the unit worked. The roof buckled up and a 16-foot door blew off into the driveway. The fact is you cannot get away from that. Yet, people will put a 25,000 or 30,000 CFM exhaust fan and leave the doors closed and wonder why it doesn't work. It can't work.

If you look at all the processes that we have, the purpose of this design of our concept approach is that your building requires air and it's a variable amount. By taking the two sets of dampers that variable air handler down at the bottom, by operating those two, those two dampers actually float. Eighty percent of the air that the fan handles because it would be either bypassing a room or outside air depending on the space requirement. You can actually balance your infiltration rate with this because it will follow it.

Use 1/100 of an inch water and pressure differential between inside and outside. With the DDC control system, our low range is .0097. It's really nailed to what we do with that. You can see that this is going to follow whatever the air requirements are in the building because when you put into a building like that, you slightly pressure it. If it comes in at one point, every other hole in the building is an exit point. What happens to your distribution pattern? It goes up tremendously because you have really distributed air. If you turn on the exhaust fan because this is a pressure control system, it senses that and brings in the air to maintain that exhaust fan.

We have seen operating characteristics and paint lines where we have gone with a can company from about 4.25 minutes for processing cans through a drying stage to 3.5 minutes and they handle four to six million cans a day. Talk about major change throughout. All they did was pressurize the building. That's all. It shows you that systems and things that you work on that require air unless it's supplied, aren't going to work effectively.

We have talked about the burner. It's a variable of 25 to one. You only deliver the heat required by that building. The fact is if you put 100 percent outside air into this building and it's discharging 70 degrees and the inside temperature is 65 degrees or the set point is 65 degrees, that five degrees times the amount of the CFM or 10,000 times 1.08 is your radiation loss at that point in time. That's your actual real radiation loss.

One other feature of this type of system is because of the amount of air that is handled and required by the building, the amount of the heat traveling in a cubic foot is quite low. As a result, you have low temperature heating. Average discharge temperature will be five to ten degrees above the room setpoint. That eliminates stratification. Actually one to three degrees is very typical for this type of system to work with. It doesn't make any difference how high the building is because it's the temperature differential that produces the stratifications.

What about tomorrow? Well, looking at EPA and the fact is we did work with Amtrak and their border system for their buildings. Their maintenance had reached a point with the EPA and they gave a time that they were going to shut them down or they were going to rebuild or replace them. They went with this type of system. Now it has been up about a year. I haven't heard the results, but I haven't heard a complaint from there either.

However, I know what the results are. There's at least a 50 percent drop in operating costs just in energy. In maintenance costs there will probably be another 10 or 15 percent drop because there's very little maintenance with this type of equipment. You are going to see more of that coming as ventilation and clean air where they are working on is a real requirement.

I took a couple of things out of a magazine and these are saying the same things. Ventilation is the key. Air is the key. How important is it? Well, this is about four years old, but \$60 billion annually is lost in productivity because of air quality in the industry. You know it's good when the lawyers get into it because the average settlement cases run about \$500,000 whether it's lead or whatever it happens to be.

This is the real shocker and this again is about four years old. It's more than Aids and automobile accidents put together because it's only the tip of the iceberg. Those are the reported ones. It says nothing for the person who works 30 years in an environment which is slowly poisoning him. When he retires, he dies two years later and they don't associate it with the fact that it took 32 years for him to die because of his environment. That is an enormous figure in the industry today. I look at the 1990s with all the emphasis on IAQ and EPA and clean air and all the things that you are doing and there's no way that the industry is not going to get hit and have to face this. The technology to handle it has already been here. It has been here 50 years surprisingly to do it and clean it up.

Now for some quick applications. This was a six-month payback to show you the change from an oil fire system to a direct fire system. They kept adding buildings to the structure. It is very easy to add to because you don't have any duct work. Based on the volume you add, you supply the same air change rate and temperature and pressure setting and you are hooked together.

Here's an indoor football practice field at the University of Michigan. It is very versatile. Again, it's just air.

How many people recognize this? It is Paducah, Kentucky, where they repair locomotives. The tall building in the center is about 95 to 100 feet high. There are no floors. That's all glass. It was built from 1910 to 1915. They had oil fire boilers and that was killing them. They went to gas fire boilers and they still were having problems cost wise and it was putting them out of business. They went to a direct fire system and there really is the scientific sophisticated technology that you have here. They have the return or bypass through the lower window and they supply air going in through the upper window and they raise the whole thing up so it fits without touching the building structure. That's the distribution right through that. There is nothing on the other side of that but two holes, one in and one out. It does a fantastic job. You couldn't see down into the welding bay before. Even in the summertime, they couldn't. But now this is what it looks like all the time.

It was a good experiment for us in a way. They had one system that went to this and they went to this prior to our DDC control system. When we came out with our DDC control system, one of the problems they had was they had all the efficiency but the controls were sitting out on the walls of these different buildings. Believe it or not people on the factory floor could take a screwdriver and go in and turn it to 80 degrees or do a lot of things. It really wasn't that difficult.

This last fall we retrofitted the control system. They had it up and running January 1st. From January 1st to the end of March in those three months they recorded a \$55,000 adjusted savings versus last year for the same period for the same degree day variance. It shows you what a good control system will do with the right equipment.

This is what goes on today in an airplane hanger where there are 737s and DC10s. It's 100 feet high and there are three units on each end. They have three units in the place. They also have three for backup in case they have to open a door. When you open a door in a hanger like this, the wall gets removed. When they want to get it heated back up again very quickly, they do that.

There are people who say you cannot pressurize a large building. I have been with automotive vice-presidents in Detroit, engineering people, who have said you can't pressurize a large building. Right north of them is the Pontiac Silverdome. If you look at it, that's a pressurized building. They maintain .9 to 1.20 inches water column. That's a lot more than most duct work. I have stood on the top of that building. It's only about the thickness of a pair of

denim pants and I looked through a hole at 220 feet approximately and I can watch the Lions practicing football. It really is that thin.

So you can pressurize a large building and we do it 1/100 of an inch and that's where you start controlling air. Until your building is positive, you do not have air control. If air is a requirement for what you are working with, this is the system to work with. Fortunately, you can add heat to it. You can add cooling to it. You can add filtering to it. You can add humidification, and dehumidification or whatever you want to do because it is an air handler. But it all starts first with pressurizing your building.

If you don't pressurize your building, it's going to look like that. This is the kind of control that you will have.

I think I just set a record for going through this. I appreciate your efforts. Thank you very much. (Applause)

Mr. Van Huis: Thank you, Al. Our next presentation is an AREA choice on dynamic bridge loadings. For those of you who don't know, we've started an exchange program with AREA. This is their choice. Next March we will present a feature to their attendees. Jose Cavaco is currently bridge rating engineer for CN North America. He has a Master's Degree in engineering. He is a member of the Corporation of Professional Engineers of Quebec and he has co-authored several publications dealing with bridge failures and rehabilitation. Would you please welcome Jose. (Applause)

DYNAMIC LOADING OF STEEL STRUCTURES

Jose Cavaco

CN North America

What I am about to present today concerns itself primarily with the problems we are faced with due to the type of increasing loads that the railway industry is being forced to accept to remain competitive, not only within its own network of railroads, but also with other forms of transportation such as the trucking industry. This has forced us to develop more and more efficient and cost-effective rolling stock onto our rail lines.

In this presentation, I will first talk a bit about the history and the changes in railroad loading from about the turn of the century to the present time and follow up with a discussion on how the AREA design specifications have tried to keep up with these changes and explain what can be done to prepare ourselves for the new wave of heavier cars on our structures.

I will also very briefly expose some of the problems that today's heavier cars are creating on our existing steel bridges.

Let's begin by having a look at the average car capacity increase for the period from 1929 to 1992. This data is available from Railway Facts published by the AAR and demonstrates that car capacity has continually increased during this period of time. Following the same trend, it can be expected that the average car capacity by the beginning of the next century will be at 100 tons. What this means is that in order to obtain this average car capacity, we will undoubtedly be handling a substantial number of cars over 100 tons capacity.

This is the typical heaviest box car that was being handled in regular service in the 1920s. It's a typical 40-foot long, 40-ton capacity box car operating during that period. For comparison, this is at present the heaviest type of regular rolling stock in service on the majority of Class I railroads with a capacity of 125 tons and a height of up to 20 feet 2 inches.

The following slides will also demonstrate how train loads have been steadily creeping up with both heavier types of cars and locomotives. This is one of the earliest trains of the 1880s. This is the train of the 1940s. The trend to heavier loading is quite evident when comparing the previous slides. The heaviest loads up to this time came from steam locomotives and design of bridge structures were governed by these monstrous machines.

By the end of the 1960s, 100-ton cars were well established as regular equipment and were used in almost all of unit train service.

This is the type of cars we are handling today. Ever since 315,000 pound cars and double-stack containers were first introduced in the mid 1980s, more and more of these heavier cars have become the common sight on most Class I freight carrying railroads.

The question is how have we traditionally coped with the introduction of heavier and heavier rolling stock? Since the turn of the century we have relied on Cooper's loading to design our bridges. This loading consists of two steam locomotives with the above constant wheel spacing configuration followed by uniform load. As can be seen, the wheel loading has progressed through the years from E40 back in 1895 to E80 loading which is still used today. Traditionally, these loadings have always been more than adequate to handle any equipment loading of the time. The reason for that being that heavy steam locomotives were the governing loads.

You will note that the ultimate loading is no longer part of the design requirements. This alternate loading allowed for the heavier design of short bridge members which are susceptible to more frequent cyclic loading and thus more fatigue prone. For some reason, this loading requirement was eliminated back in 1947. The significance of this type of loading will become clearer as we progress.

This next slide gives us an appreciation of the amazing development and growth of these work horses during the first six decades of the century. By the end of the steam era, massive steam locomotives such as the Alco single expansion articulated engines weighing close to 800,000 pounds were moving fairly light freight cars by today's standards across the country. Technological progress eventually put the steam locomotives to pasture with the development of the more efficient diesel locomotive. This diesel locomotive weighs just under 400,000 pounds, but it delivers a maximum 4,000 traction horsepower.

As was seen from the previous slide of various Cooper design loadings, the E72 loading introduced in 1935 was sufficient to maintain adequate capacity to handle the heaviest steam locomotives whose loading always governed over any other regular equipment and as a result a change to this loading did not become necessary until the 100-ton cars were introduced. When unit trains of 100-ton cars were placed into regular service, it was realized that the present design loading was no longer adequate especially to handle the fatigue problem that these cars were creating. Consequently it was changed in 1967 to E80. Today, we are again confronted with heavier car capacities with the introduction of the 315,000 pound cars and double-stack containers. The consequences of operating these heavier cars is that the stresses produced by this equipment may exceed the present E80 design criteria for the shorter bridge spans.

This is a slide comparing the E rating of two 263 kip cars with the 315 kip cars presently in service based on moments produced by these cars in spans 8 to 400 feet. There still exists a good margin for expansion for both of the regular shorter 100-ton cars, but looking at the 125-ton cars, we can see that the design limit of E80 does not leave much future capacity for the shorter spans.

Many railroads have recognized the need for higher loading design as soon as it was realized that the 125-ton car would become part of regular service equipment and many such as CN North America have since chosen to design their bridges to E90 loading.

When we look at who is running these heavy cars we find that according to the 1993-1994 Railway Line Clearances Publication, of the Class I freight railroads which make up 93 percent of total freight revenues, nine of these major carriers already accept 315,000 pound

cars. With the acceptance of the heavier cars by the majority of Class I freight railroads, the need to increase the AREA live load design requirements becomes clear.

As already demonstrated, these approved heavy loads are too close for comfort on short span lengths. There is a reluctance to increase E80 to higher design loading due to mechanical departments' propensity to design and force even higher loads as the cost to upgrade rail cars' heavier loads is minimal. It's just a matter of increasing the plate size from 1/2 to 5/8. Many arguments can be used to contest the introduction of heavier cars, but the reality is that the drive to provide a more efficient and economically competitive service will always push for the development and utilization of these cars.

I think the previous slide showing the historical tendency for increased car capacity over the past 60 years clearly demonstrates the need to ensure that bridges are designed for the long-term. An interesting point to bring out at this time is that we have always taken for granted that 100-ton capacity cars were loaded to their maximum capacity and occasionally overloaded within tolerable limits. This is what we at CN perceived until the initiative was taken to monitor the overload situation by installing overload car detectors. These scales were positioned at strategic locations and what we are finding is a bit disturbing, to say the least, as the next few slides will show.

This is a typical unit coal train of 100 ton cars. What we have found in reality is that a good number of these cars are loaded in excess of 100 tons. Looking at the analysis of data collected from 17 mostly loaded westbound trains that were marshaled through the overload car detector located in our Jasper Yard between the period of June 6th and June 30th of this year, it was found that not only were a large percentage of cars overloaded by as much as 20,000 pounds, but a more disturbing finding shows that in many instances the load was not equally distributed on the cars themselves. Truckloads on these trains were unevenly loaded by as much as 15,000 pounds.

This next slide shows the histogram of car loadings for the sample trains giving the RMC value for this loading at 252.8 kips. If we were to take the same train data and place all overloaded cars in the 263 pound range of the histogram as they were intended to be in the first place, then we get an RMC value for the same sample of trains of only 241 kips.

In terms of fatigue life of steel bridges, this difference is significant because fatigue damage is a cubic function of stresses. In other words, say a 10 percent increase in stresses will reduce the life of a steel span by approximately 25 percent. For those of you who are familiar with the fatigue life curves, you will appreciate that a shift in load to heavier cars including the overloads will result in an increase in the RMC value and consequently decrease the available fatigue life of steel spans by a significant amount.

This slide is a good illustration of what is happening and how steadily increasing load patterns shift the RMC value from a position where fatigue distress is of little concern to a position above the critical cut off point where fatigue damage comes into play affecting the life of the structure.

Going through the data, I located a train with a considerable number of consecutively heavy overloads and obtained a rating for these series of cars assuming they were all 52 feet 6 inches long. I re-did the rating for the same loading using 47 foot long cars and then I obtained a rating using 47 foot long 125-ton cars assuming they were overloaded by the same percentage as the sampled 100-ton cars. As you can see, the spans that suffer the most are again the short ones indicating that an increase in the design loading is needed specifically to protect these spans.

Basically what I have tried to demonstrate is that we have now reached a point where the design load is about the same as the actual load so the problem we are faced with is how to design for the future. One way is to increase the Cooper's design loading which has already been adopted by several railroads. However, there is a reluctance to go to this way because this gives the mechanical departments the incentive to increase car capacities even further.

Another problem is that among railroads no consensus as to what design loading to adopt has yet been reached. One method of designing for the future would be to reintroduce two-axle alternate loading which was dropped back in 1947. This takes care of the short timber spans but does not solve the real problem. A more practical solution would be to introduce the new four-axle alternate load. This is a workable compromise that relates to the real situation just as Cooper loading effectively related to the rail situation of the heaviest locomotive loads during the steam era.

This slide illustrates the proposed change to the AREA live load design. The design loading of E80 remains unchanged. We still have two locomotives as before with the same wheel configuration and loading. The only difference is the introduction of an alternate load consisting of four 100-kip axle loads with spacing of five feet six inches, and five feet. This is being adopted as the best alternative after many discussions of different proposals because it effectively addresses the problem created by the new generation of cars on spans up to 50 feet in length.

This slide showing the maximum forces produced by this proposed loading shows that the four-axle alternate load only governs for spans up to 50 feet. Forces produced by the alternate load are identified here by an asterisk. This is ideally what we would like to have happen because this type of load addresses the real situation out there and ensures that fatigue susceptible shorter spans are safeguarded.

The comparison of this type of loading and the heaviest type of regular rolling stock shows not only a clear safety margin but also sufficient capacity for future development. When we compare the 315,000 pound car rating with the E80 loading now revised to consider the four-axle loading, we can see more clearly that there exists an acceptable margin of safety and room for future growth.

There are other solutions to this problem such as increasing the axle loads by 25 percent up to 50-foot spans lengths, but this only produces an absurd step function. For example, the design of 49.99 foot span would use 100 kip loads but the 50.001 foot span would require 80 kip loads. Steam impact could be used to get the same result, but this is not realistic and would only be used as a sham to get around reality as well as creating regulatory problems. You could get around the problem by reducing the allowable stresses but this again would create regulatory problems and would prove difficult as many design aids use standards stresses for different bridge designs. As well, this solution would create the impression of excess conservatism.

In summary, what I have tried to convey today is the need for higher design loading. A loading which AREA committee 15 has proposed and is the result of five years of compromise. The AREA manual should not be a minimum safety requirement, but represent good practices because designing for little or no allowance for the future is not good practice.

Up to now, I have talked about the requirement for future bridge designs, but this opens up quite a number of questions on the consequences of increased carloading on existing bridges. No doubt many problems will be encountered; the most serious of which is how to deal with fatigue.

Briefly, the following slides will illustrate two situations directly related to the problem. This is a 1,122 foot long deck plate girder viaduct of recent welded construction built in 1967 which has been subjected to less than 8 million gross tons per year. Yet, even with low tonnage and the absence of 125-ton car traffic on this bridge, a considerable number of cracks have been developing in the web as shown here at the connection to the stiffener plate. The stiffener plates are on the inside of the girder.

Another more serious problem has been recently discovered on truss spans. This is a bridge which receives substantially more traffic, up to 55 million gross tons per year, and was built in the early part of the century. The problem occurred on the rib of the truss span, specifically, on the top hanger connection of the truss. The hanger consists of four angles connected together by intermittent tie plates. One of the angles developed a fatigue crack that

originated at the rivet hole and continued to propagate all the way along the connecting angle and up the vertical one until it no longer had sufficient capacity to support the load and fractured completely.

This is just a view of the hanger which was repaired. This is the temporary repair. This is the remaining section of the hanger that was fractured and you can see the outline of the angles and the bolts connecting the splice plate all the way down to the remaining section of the hanger. If you are lucky, these types of cracks would be detected before failure occurs and in time to prevent a major catastrophe. Otherwise a more reliable way to avoid such situations short of initiating a major immediate and expensive retrofitting program is to ensure that regular detailed inspections are performed in those areas susceptible to fatigue failure.

I have shown just two examples of problems which have developed due to the fact that these bridges have been subjected to heavier and more frequent loading especially during the last two decades. What we need to realize today is that if we are going to avoid similar problems with our newly constructed bridges in a much shorter period of time, we have to start putting some extra reserve capacity into our present design specifications.

With that last note, I will complete my presentation. Thank you for your attention. (Applause)

President Steele: Thank you, Jose, and I apologize to some of the presenters that we had to cut short. I want to thank all the gentlemen for their fine presentations. It was worthwhile information.

At this time, I would like to take the opportunity to present the plaques to the outgoing directors for their participation and guidance over the past several years. Carl Young who got called out on emergency will not be here, but will Bob Carter and Dave Franz please come forward.

Bob Carter is going to be our junior vice-president this year so he is going to move right on into another three years here. Bob, thank you very much. (Applause)

Dave must have stepped out, so I will give it to him privately.

At this time, I will give the podium over here to Gene Schubel for his presentation.

President Schubel: Thank you, Don. I would like to have Wayne Russell, Ray Brosseau, and Dave Smoot come up. I would like to present you three with plaques in appreciation for all you have done on the Roadmaster's board as directors. This is in appreciation for that effort. (Applause)

President Steele: Thank you, Gene. At this time I would call on Reuven Shiloh to read the Resolution Committee Statement.

RESOLUTION COMMITTEE STATEMENT

Having reached the closing of the annual joint conference of the American Railway Bridge and Building Association and the Roadmasters and Maintenance of Way Association of America and being deeply indebted to all those members and friends who have contributed their time and efforts to make our conference a success, it is right that we should acknowledge this indebtedness, and that it shall be so entered into the minutes of this meeting.

Be it further resolved, that our deep appreciation be extended to those who have honored our associations with their presence and by their informative addresses. Those include: Harris Wagenseil, vice-president maintenance, Union Pacific; Herbert Robinson, vice-president operations, Burlington Northern; Jolene Molitoris, FRA Administrator; Cliff Shoemaker, Union Pacific; Duncan MacLennan, CN North America; Richard Reynolds, Union Pacific;

Gordon Barksdale, American Inland Divers; Leonard Lokey, Osmose; Kelly Pathol, PSSI, Ed Butt, director technical training, Burlington Northern; Bob Tuzik, Railway Track and Structures, Billie Terrell, B.P. Terrell and Associates; Benny Howe, FRA; Mark Huston, Burlington Northern; Joseph Noffsinger, Conrail; Richard Klein, Conrail; Mark Johnson, Burlington Northern; Willie Benton, Norfolk Southern; Steve McNaughton, Union Pacific; Lowell Eby, director of material distribution, Burlington Northern; Vincent Terrill, who did a find job representing the many innovations of REMSA; and to all the committee chairmen and sponsors, who with the loyal cooperation of the committee members, prepared the interesting and instructive reports that have been presented.

Be it further resolved that a very special thanks is expressed to Ken Norton, president of REMSA, and to all members of the Railway Engineering Maintenance Suppliers Association for the fine reception and hospitality that we enjoyed during our conference.

Our thanks are also expressed to Mrs. Janice Steele, Mrs. Rita Schubel, and Frances Dachs, and the committee members for their efforts in arranging registration and entertainment for our wives. Our thanks also to Rosanna Morales, Ian Thomson, and the Westin Hotel staff whose outstanding efforts contributed to a highly successful conference. A special thanks goes to Pat Weissmann and Barb Marlow. Without their unselfish assistance, these two Associations would have great difficulty functioning.

And be it finally resolved that both Associations express their heartfelt thanks to our retiring presidents, Don Steele and Gene Schubel, who have spent so much time and effort in guiding the activities of our two Associations with great efficiency and dedication during the past year.

I move this resolutions be adopted.

Respectfully submitted,

Reuven Shiloh

President Steele: At this time, I would like to call on our immediate past president, Paul Saletnik, for the installation of officers.

Mr. Saletnik: Thank you, Don. The following are the names of the officers-elect of the America Railway Bridge and Building Association for the administrative year 1994-1995. The officers so named please step forward in front of the podium.

President, John Van Huis, chief engineer structures and production, Wisconsin Central, Fond du Lac, Wisconsin.

Senior vice-president, Mike Bradley, project engineer, Conrail, Columbus, Ohio.

Junior vice-presidents: Joe Lileikis, senior engineer structures, Amtrak, Philadelphia, Pennsylvania; Bob Carter, general B&B supervisor, Burlington Northern, Springfield, Missouri.

Treasurer: Don Lewis, assistant engineer bridges, Illinois Central, Chicago, Illinois.

Directors for terms expiring in 1995: Lee Hostler, structures engineer, Santa Fe, Belen, New Mexico; Jimmy Neece, supervisor facilities maintenance, CSX, Helena, Alabama; Ron Kaye, bridge engineer, Illinois Central, Chicago, Illinois.

Directors with terms expiring in 1996: Mark Johnson, manager structures, Burlington Northern, Springfield, Missouri; Tim Rich, engineer B&B, Conrail, Indianapolis, Indiana; and Dale Bartholomew, senior project manager railroad facilities, Sverdrup Corporation, Kirkland, Washington.

Directors with terms expiring in 1997: Patrick L. Barrett, engineer construction and maintenance, Santa Fe Railway, Kansas City, Kansas; Richard C. Dumar, manager architectural design, Union Pacific Railway; and David W. Cook, B&B supervisor, Montana Rail Link, Missoula, Montana.

I will now turn the podium over to Mr. Cossel.

Mr. Cossel: Following are the names of the officers-elect of the Roadmasters and Maintenance of Way Association for the administrative year 1994-1995. Will the officers so named please step up and take a position in front of the podium.

President, Keith Nordlund, project manager CN North America, Toronto, Ontario.

First vice president, Ken Koff, manager maintenance-of-way, Amtrak, Los Angeles, California.

Second vice president, Wayne Russell, general director roadway maintenance and planning, Santa Fe, Kansas City, Kansas.

Treasurer, Ron Poulsen, senior project manager, HDR Engineering, Omaha, Nebraska.

Directors with terms expiring in 1995: Darrell Cantrell, director of service agreement, Burlington Northern, Fort Worth, Texas; Ken Johnson, regional manager gangs, CSXT, Spanish Fort, Alabama; and Dave Kelly, vice president maintenance, Illinois Central, Chicago, Illinois.

Directors with terms expiring in 1996: Al Cloutier, division engineer-commuter, Amtrak, Boston, Massachusetts; Reuven Shiloh, director of engineering planning and support, Conrail, Philadelphia, Pennsylvania; and Peter Murgas, engineer procedures and administration, Norfolk Southern, Atlanta, Georgia.

Directors with terms expiring in 1997: Bob Davis, production manager ties, Southern Pacific, Redlands, California; Dwight Clark, director quality management, Union Pacific, Omaha, Nebraska; and Ray Brosseau, manager track programs, Canadian Pacific Rail, returning as a director with a term expiring in 1997.

Directors with terms expiring in 1998: Bob King, supervisor engineering maintenance, CP Rail, Wood Dale, Illinois; Tom Long, manager of engineering services, Indiana Harbor Belt, Hammond, Indiana, and Joe Riley, engineer standards, METRA, Chicago, Illinois.

Mr. Saletnik: As the officers of our Associations, you will represent to the citizens of this country the true meaning of railway bridge and building and roadway maintenance and construction. You will be our collective voice in the industry. Thus you will be our common bond with the railway personnel throughout the United States and the world.

Mr. Cossel: As the officers of our Associations, you will represent our best interest in any of our activities or projects, always reminding yourselves that your attitude must be a part in any undertaking sanctioned by your respective associations. In this, you will be adhering strictly to the constitution and bylaws of our respective associations. As a representative of the Roadmasters and Maintenance of Way Association of America, I install each of you in the office to which you have been elected.

Mr. Saletnik: As a representative of the America Railway Bridge and Building Association, I install each of you in the office to which you have been elected. Please remain standing so that Mr. Cossel and I can come down and congratulate each of you. The audience may now applaud. (Applause)

President Steele: At this time, I would like to call on Ken Norton, president of REMSA.

Mr. Norton: Don, thank you and good morning. My able assistant here is Judi Meyerhoeffer who is executive director of REMSA. REMSA is pleased to be able to present each of the immediate outgoing presidents with commemorative plaques. I guess I also have to say that I really appreciate the close way that both B&B and Roadmasters worked with REMSA this year. It has really been nice. I also have to say that I have really enjoyed the opportunity to work with both Don Steele and Gene Schubel. Would you two gentlemen please come forward.

We are also pleased to present gavels which are symbolic of the office for the two new presidents, John Van Huis, president of the B&B Association, and Keith Nordlund, president of Roadmasters. Even though they are symbolic, they can always be used when reason doesn't prevail. If they would come forward please.

Thank you very much and we have enjoyed being part of your meeting. (Applause)

President Schubel: And for Keith Nordlund, I would like to give you your president's pin and allow to you to make your formal statement.

President-elect Nordlund: Thank you, Gene, and thank you for all your assistance in the past and your leadership. Also thank you to Ken Welch, of course, who was your predecessor.

I am indeed proud and honored to serve as President of this Association for this next term. To the members of this Roadmasters Association, I have every reason to believe that we are in for another challenging year. I approach this assignment with a certain amount of awe and enthusiasm. I am looking forward to another full year of activities and hopefully will provide some energy and effort to this leadership. I can assure that I will give it my best effort.

I am blessed with a knowledgeable and dedicated group of Executive Board members and I am sure as in the past we will work together as a team.

As most of you know, I am from Canada. Being from Toronto, of course, home of the Toronto Blue Jays who are the world champions and with the canceling of the season, we are good for another year. (Laughter)

For another thought, in CN we no longer have roadmasters by title. It is somewhat sexist so here I am now a President of a Roadmasters Association. But there are no more B&B masters or trainmasters at CN.

I have been a member of this Association for 20 years and for the first 13 years as a non-active dues paying member. However, with the influence of John Swiderski, retired CN and former director, he convinced me to take on a task as a committee chairman. Because of that personal involvement, my eyes became opened. I came to understand the Association, where it fits in and the effort that is needed to make it all tick and provide value to the members. That last point, value to the members, is what each of you make of it.

I encourage you to volunteer to work on a committee or lead a committee. That in itself will give you value from personal knowledge and from personal experience from the knowledge you will gain and the contacts with others. Even go back to your own company and encourage someone else to join and participate. The bottom line, of course, is it makes you feel better when you make out the check to pay the annual dues.

We have another year ahead of us and then we will meet in Minneapolis. As Gene Schubel stated, we now have set a five-year strategic plan in the Roadmasters Association to move forward and to be even more responsive to the rail industry and increase the value to our members. We can truly do this by tapping the ideas, the experience, and the intellect of the members to fulfill the mission of this Association.

I thank you. I am looking forward to seeing you in Minneapolis in 1995. Thank you. (Applause)

President-elect Van Huis: Don, would you come forward please. On behalf of the Association, REMSA, and all your members, I would like to present you with a plaque for your service.

Mr. Steele: Thank you very much. (Applause)

President Van Huis: I just have a couple of comments and I hope I can do just as well a job as my cohort, Don, has done. I look forward to working with the boards, Roadmasters and REMSA, next year and we will everybody in Minneapolis. Thank you. (Applause)

President Nordlund: Gene, could you come forward. Gene, I would like to present to you this appreciation award in recognition of a full year of activity and leadership with the Association as President. Thank you.

Mr. Schubel: Thank you. (Applause)

President Nordlund: I would like to now to declare this conference closed.

(Adjourned)

Past Officers

	1891-1892	1892-1893	1893-1894	1894-1895
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews
1st V.-Pres.	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle
2nd V.-Pres.	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford
3rd V.-Pres.	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard
4th V.-Pres.	G. W. Hinman	C. T. Fuller	E. D. Hines	Walter G. Berg
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	George M. Reid	George M. Reid	George M. Reid
Executive Members	W. R. Damon	G. W. Andrews	Q. McNab	James Stannard
	G. W. Markley	J. M. Staten	A. S. Markley	James H. Travis
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin
	C. W. McGehee	Q. McNab	James Stannard	R. M. Peck
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane

	1895-1896	1896-1897	1897-1898	1898-1899
President	W. A. McGonagle	James Stannard	Walter G. Berg	J. M. Cummin
1st V.-Pres.	L. K. Spafford	Walter G. Berg	J. H. Cummin	A. S. Markley
2nd V.-Pres.	James Stannard	J. H. Cummin	A. S. Markley	C. C. Mallard
3rd V.-Pres.	Walter G. Berg	A. S. Markley	G. W. Hinman	W. A. Rogers
4th V.-Pres.	J. H. Cummin	R. M. Peck	C. C. Mallard	J. M. Staten
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes
	L. J. White	W. M. Noon	C. P. Austin	J. H. Markley
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman

	1899-1900	1900-1901	1901-1902	1902-1903
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd V.-Pres.	J. M. Staten	B. G. Pickering	A. Shane	A. Shane
3rd V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith
	R. L. Heflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichy
	H. D. Cleaveland	W. E. Smith	C. A. Lichy	W. O. Eggleston
	A. Montzheimer	A. W. Merrick	W. O. Eggleston	J. H. Markley

	1903-1904	1904-1905	1905-1906	1906-1907
President	A. Montzheimer	C. A. Lichy	J. B. Sheldon	J. H. Markley
1st V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid
2nd V.-Pres.	C. A. Lichy	J. H. Markley	R. H. Reid	J. P. Canty
3rd V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	W. O. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907-1908	1908-1909	1909-1910	1910-1911
President	R. H. Reid	J. P. Canty	H. Rettinghouse	H. Rettinghouse
1st V.-Pres.	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichy	C. A. Lichy
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S. Lemond	Willard Beahan	F. B. Scheetz	G. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912	1912-1913	1913-1914	1914-1915
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres.	T. J. Fullem	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	F. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
Directors	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
	A. B. McVay	A. B. McVay	J. H. Johnson	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W. Wright	J. H. Johnston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

	1923-1924	1924-1925	1925-1926	1926-1927
President	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres.	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres.	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres.	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres.	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	P. L. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres.	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres.	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres.	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres.	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise		
Directors	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

	1934-1935	1935-1936	1936-1937	1937-1938
President	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres.	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres.	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres.	A. B. Scowden	F. H. Masters	G. A. J. Richards	C. A. J. Richards
4th V.-Pres.	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
Directors	C. S. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCloy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938-1939	1939-1940	1940-1941	1941-1942
President	Armstrong Chinn	A. E. Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres.	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres.	A. E. Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres.	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres.	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.	C. A. Lichty	C. A. Lichty		
Secretary			F. O. Whiteman	A. G. Shaver
Treasurer			F. E. Weise	F. E. Weise
	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
Directors	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudle	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

	1942-1943	1943-1944	1944-1945	1945-1946
President	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
	M. Meyer	W. F. Martens	W. F. Martens	A. B. Chapman
Directors	L. E. Peyser	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	K. L. Miner	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	F. G. Campbell	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	J. S. Hancock	A. B. Chapman	A. B. Chapman	B. R. Meyers
	L. C. Winkelhaus	L. E. Peyser	L. E. Peyser	L. E. Peyser

† To November 1, 1942 ‡ To February 1, 1943

	1946-1947	1947-1948	1948-1949	1949-1950
President	F. G. Campbell	J. S. Hancock	E. H. Barnhart	W. F. Martens
1st V.-Pres.	J. S. Hancock	E. H. Barnhart	W. F. Martens	W. A. Huckstep
2nd V.-Pres.	E. H. Barnhart	W. F. Martens	W. A. Huckstep	Guy E. Martin
3rd V.-Pres.	W. F. Martens	W. A. Huckstep	Guy E. Martin	F. R. Spofford
4th V.-Pres.	W. A. Huckstep	G. E. Martin	F. R. Spofford	Lee Mayfield
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	C. R. Knowles	C. R. Knowles	L. C. Winkelhaus	L. C. Winkelhaus
	Guy E. Martin	H. M. Harlow	Lee Mayfield	H. M. Harlow
Directors	B. R. Meyers	H. B. Christianson	F. M. Misch	V. E. Engman
	L. E. Peyser	F. R. Spofford	W. D. Gibson	G. W. Benson
	H. M. Harlow	Lee Mayfield	H. M. Harlow	F. M. Misch
	H. B. Christianson	Franz M. Misch	V. E. Engman	L. R. Morgan
	F. R. Spofford	W. D. Gibson	G. W. Benson	J. A. Jorlett

	1950-1951	1951-1952	1952-1953	1953-1954
President	W. A. Huckstep	Guy E. Martin	F. R. Spofford	Lee Mayfield
1st V.-Pres.	Guy E. Martin	F. R. Spofford	Lee Mayfield	H. M. Harlow
2nd V.-Pres.	F. R. Spofford	Lee Mayfield	H. M. Harlow	J. A. Jorlett
3rd V.-Pres.	Lee Mayfield	H. M. Harlow	J. A. Jorlett	R. R. Gunderson
4th V.-Pres.	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
	F. M. Misch	M. H. Dick	W. H. Huffman	M. H. Dick
Directors	L. R. Morgan	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells
	J. A. Jorlett	J. F. Warrenfells	B. M. Stephens	G. Switzer
	M. H. Dick	W. H. Huffman	M. H. Dick	B. M. Stephens
	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells	W. H. Bunge
	J. F. Warrenfells	B. M. Stephens	G. Switzer	E. R. Schlaf

	1954-1955	1955-1956	1956-1957	1957-1958
President	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
1st V.-Pres.	J. A. Jorlett	R. R. Gunderson	W. H. Huffman	M. H. Dick
2nd V.-Pres.	R. R. Gunderson	W. H. Huffman	M. H. Dick	B. M. Stephens
3rd V.-Pres.	W. H. Huffman	M. H. Dick	B. M. Stephens	H. D. Curie
4th V.-Pres.	M. H. Dick	B. M. Stephens	H. D. Curie	
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
	B. M. Stephens	J. F. Warrenfells	W. H. Bunge	G. W. Benson
Directors	W. H. Bunge	H. D. Curie	E. R. Schlaf	J. M. Lowry
	E. R. Schlaf	J. M. Lowry	G. W. Benson	
	J. F. Warrenfells	W. H. Bunge	J. M. Lowry	
	H. D. Curie	E. R. Schlaf	T. M. VonSprecken	
	J. M. Lowry	G. W. Benson	H. A. Matthews	

	1958-1959	1959-1960	1960-1961	1961-1962
President	M. H. Dick	B. M. Stephens	H. D. Curie	G. W. Benson
1st V.-Pres.	B. M. Stephens	H. D. Curie	G. W. Benson	J. M. Lowry
2nd V.-Pres.	H. D. Curie	G. W. Benson	J. M. Lowry	E. R. Schlaf
3rd V.-Pres.	G. W. Benson	J. M. Lowry	E. R. Schlaf	H. A. Matthews
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
	J. M. Lowry	W. H. Bunge	H. A. Matthews	R. C. Baker
Directors	R. C. Baker	E. R. Schlaf	M. J. Hubbard	R. H. Miller
	W. H. Bunge	H. A. Matthews	R. C. Baker	Shirley White
	E. R. Schlaf	M. J. Hubbard	R. H. Miller	H. M. Wilson
	H. A. Matthews	R. C. Baker	Shirley White	R. D. Hellweg
	M. J. Hubbard	R. H. Miller	H. M. Wilson	F. W. Hutcheson

	1962-1963	1963-1964	1964-1965	1965-1966
President	J. M. Lowry	E. R. Schlaf	R. C. Baker	H. M. Wilson
1st V.-Pres.	E. R. Schlaf	R. C. Baker	H. M. Wilson	R. D. Hellweg
2nd V.-Pres.	H. A. Matthews	Shirley White	R. D. Hellweg	J. W. DeValle
3rd V.-Pres.	R. C. Baker	H. M. Wilson	J. W. DeValle	W. F. Armstrong
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	E. F. Snyder	E. F. Snyder	E. F. Snyder
	Shirley White	R. D. Hellweg	W. F. Armstrong	J. A. Goforth
Directors	H. M. Wilson	F. W. Hutcheson	J. S. Ellis	E. E. Simmons
	R. D. Hellweg	F. W. Armstrong	J. A. Goforth	N. D. Bryant
	F. W. Hutcheson	J. W. DeValle	E. R. Simmons	A. R. Dahlberg
	W. F. Armstrong	J. A. Goforth	N. D. Bryant	J. S. Ellis
	J. W. DeValle	E. R. Simmons	A. R. Dahlberg	T. L. Fuller

	1966-1967	1967-1968	1968-1969	1969-1970
President	R. D. Hellweg	J. W. DeValle	W. F. Armstrong	J. A. Goforth
1st V.-Pres.	J. W. DeValle	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg
2nd V.-Pres.	W. F. Armstrong	J. A. Goforth	A. R. Dahlberg	T. L. Fuller
3rd V.-Pres.	J. A. Goforth	A. R. Dahlberg	T. L. Fuller	N. D. Bryant
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
	N. D. Bryant	J. S. Ellis	N. F. Lucas	W. H. Rankin
Directors	A. R. Dahlberg	T. L. Fuller	W. L. Short	E. E. Runde
	H. F. Lucas	R. A. Youngblood	C. E. Wachter	T. A. Reynolds
	J. S. Ellis	H. F. Lucas	A. C. Jones	J. J. Ridgeway
	T. L. Fuller	W. L. Short	W. H. Rankin	J. R. Williams
	R. A. Youngblood	C. E. Wachter	E. E. Runde	J. W. Chambers
	V. D. Raessler	A. C. Jones	T. A. Reynolds	R. E. Frame
	W. L. Short	W. H. Rankin	J. J. Ridgeway	J. C. Hobbs
	C. E. Wachter	E. E. Runde	J. R. Williams	

	1970-1971	1971-1972	1972-1973	1973-1974
President	A. R. Dahlberg	T. L. Fuller	N. D. Bryant	E. E. Runde
1st V.-Pres.	T. L. Fuller	N. D. Bryant	E. E. Runde	J. J. Ridgeway
2nd V.-Pres.	N. D. Bryant	E. E. Runde	J. J. Ridgeway	J. R. Williams
3rd V.-Pres.	E. E. Runde	J. J. Ridgeway	J. R. Williams	W. R. Rankin
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
	T. A. Reynolds	J. W. Chambers	R. K. Corbett	D. C. Gould
Directors	J. J. Ridgeway	R. E. Frame	J. R. Iwinski	W. S. Stokely
	J. R. Williams	J. C. Hobbs	J. S. Pritchett	W. C. Sturm
	J. W. Chambers	R. K. Corbett	D. C. Gould	J. W. Davidson
	R. E. Frame	J. R. Iwinski	W. S. Stokely	C. A. Hughes
	J. C. Hobbs	J. S. Pritchett	W. C. Sturm	W. R. Hyma
	R. K. Corbett	D. C. Gould	J. W. Davidson	O. C. Denz
	J. R. Iwinski	W. S. Stokely	C. A. Hughes	R. C. McMaster
	J. S. Pritchett	W. C. Sturm	W. R. Hyma	W. E. Brakensiek

	1974-1975	1975-1976	1976-1977	1977-1978
President	J. J. Ridgeway	J. R. Williams	W. H. Rankin	J. R. Iwinski
1st V.-Pres.	J. R. Williams	W. H. Rankin	J. R. Iwinski	W. C. Sturm
2nd V.-Pres.	W. H. Rankin	J. C. Hobbs	W. C. Sturm	D. C. Gould
3rd V.-Pres.	J. C. Hobbs	J. R. Iwinski	D. C. Gould	J. W. Chambers
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Ann Wilson
Treasurer	W. H. Huffman	W. H. Huffman	W. H. Huffman	W. H. Huffman
Directors	J. W. Davidson	W. E. Brakensiek	J. W. Davidson	W. H. Gunkle
	C. A. Hughes	O. C. Denz	M. Noyszewski	W. E. Halley
	W. R. Hyma	R. C. McMaster	W. J. Gunkle	K. L. Wammell
	W. E. Brakensiek	F. R. Lindsay	W. E. Halley	J. Budzileni
	O. C. Denz	M. Noyszewski	K. L. Wammell	B. J. King
	R. C. McMaster	W. C. Sturm	J. Budzileni	J. G. Robertson
	F. B. Lindsay, Jr.	W. J. Gunkle	J. B. King	O. C. Denz
	M. Noyszewski	W. E. Halley	J. G. Robertson	E. C. Patterson
	Jim Payne	K. L. Wammell		W. S. Stokely

	1978-1979	1979-1980	1980-1981	1981-1982
President	W. C. Sturm	D. C. Gould	J. W. Chambers	W. R. Hyma
Sr. V.-Pres.	D. C. Gould	J. W. Chambers	R. C. McMaster	O. C. Denz
Jr. V.-Pres.	J. W. Chambers	R. C. McMaster	W. R. Hyma	J. Budzileni
Jr. V.-Pres.	R. C. McMaster	W. R. Hyma	O. C. Denz	J. M. Williams
Secretary	Ann Wilson	Ann Wilson	Ann Wilson	Pat Weissmann
Treasurer	W. F. Armstrong	W. F. Armstrong	W. F. Armstrong	W. C. Sturm
Directors	J. Budzileni	O. C. Denz	J. W. Davidson	D. A. Bessey
	B. J. King	W. J. Gunkle	C. M. Russell	J. N. Michel
	J. G. Robertson	W. S. Stokely	C. M. Williams	P. H. Saletnik
	O. C. Denz	L. D. Green	D. A. Bessey	O. D. Anthony
	E. C. Patterson	C. M. Russell	J. N. Michel	J. T. Kapp
	W. S. Stokely	J. M. Williams	P. H. Saletnik	J. D. Lewis
	L. D. Green	D. A. Bessey	O. D. Anthony	J. W. Davidson
	C. M. Russell	J. N. Michel	J. T. Kapp	H. J. Laga
	J. M. Williams	P. H. Saletnik	D. J. Lewis	A. S. Uppal

	1982-1983	1983-1984	1984-1985	1985-1986
President	O. C. Denz	J. Budzileni	J.M. Williams	D. A. Bessey
Sr. Vice President	J. Budzileni	J.M. Williams	D.A. Bessey	J. T. Kapp
Jr. Vice President	J. M. Williams	D.A. Bessey	J.T. Kapp	D. J. Lewis
Jr. Vice President	D. A. Bessey	J.T. Kapp	D.J. Lewis	R. A. Tallent
Secretary	P. A. Weissmann	P.A. Weissmann	P.A. Weissmann	P. A. Weissmann
Treasurer	P. H. Saletnik	P.H. Saletnik	P.H. Saletnik	J. M. Williams
Directors	O. D. Anthony	J.W. Davidson	T.E. Kuhn	B. T. Burns
	J. T. Kapp	D.J. Lewis	D.R. Ladner	J. J. Horney
	D. J. Lewis	T.E. Kuhn	R.A. Tallent	W. J. Semoli
	J. W. Davidson	D.R. Ladner	B.T. Burns	R. E. Fronczak
	H. J. Laga	R.A. Tallent	J.J. Horney	W. P. Cunningham
	A. S. Uppal	B.T. Burns	W.J. Semoli	J. H. Smith
	T. E. Kuhn	J.J. Horney	D.W. Brookings	E. Bond
	D. R. Ladner	W.J. Semoli	W.P. Cunningham	D. L. Steele
	R. A. Tallent		J.H. Smith	M. C. Walbrun

	1986-1987	1987-1988	1988-1989	1989-1990
President	J. T. Kapp	D. J. Lewis	R. A. Tallent	B. T. Burns
Sr. Vice President	D. J. Lewis	R. A. Tallent	B. T. Burns	J. J. Horney
Jr. Vice President	R. A. Tallent	B. T. Burns	J. J. Horney	M. C. Walbrun
Jr. Vice President	B. T. Burns	J. J. Horney	M. C. Walbrun	P. H. Saletnik
Secretary	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann
Treasurer	J. M. Williams	J. M. Williams	J. M. Williams	J. M. Williams
Directors	W. H. Nelson	M. C. Walbrun	C. E. Thompson	W. H. Nelson
	J. H. Smith	S. Lipkus	H. L. Davidson	T. J. Parker
	J. J. Horney	D. L. Steele	J. A. VanHuis	R. C. Karsten
	M. C. Walbrun	C. E. Thompson	W. H. Nelson	R. C. Carter
	E. Bond	H. L. Davidson	T. J. Parker	T. V. Dunn
	D. L. Steele	J. A. VanHuis	R. C. Karsten	M. L. Bradley
	C. E. Thompson	W. H. Nelson	S. Lipkus	D. G. DeBerg
	H. L. Davidson	T. J. Parker	T. V. Dunn	D. F. Sorgenfrei
	J. A. VanHuis	R. C. Karsten	M. L. Bradley	J. A. Lileikis

	1990-1991	1991-1992	1992-1993	1993-1994
President	J. J. Horney	M. C. Walbrun	P. H. Saletnik	D. L. Steele
Sr. Vice President	M. C. Walbrun	P. H. Saletnik	D. L. Steele	J. A. Van Huis
Jr. Vice President	P. H. Saletnik	D. L. Steele	J. A. Van Huis	M. L. Bradley
Jr. Vice President	W. H. Nelson	J. A. Van Huis	M. L. Bradley	J. A. Lileikis
Secretary	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann	P. A. Weissmann
Treasurer	J. M. Williams	D. J. Lewis	D. J. Lewis	D. J. Lewis
Directors	R. C. Carter	D. G. DeBerg	D. L. McCammon	R. W. Carter
	T. V. Dunn	D. F. Sorgenfrei	J. T. Creighton	C. W. Young
	M. L. Bradley	J. A. Lileikis	J. G. Bradley	D. K. Franz
	D. G. DeBerg	D. L. McCammon	R. W. Carter	J. L. Hostler
	D. F. Sorgenfrei	J. T. Creighton	C. W. Young	J. L. Neece
	J. A. Lileikis	J. G. Bradley	D. K. Franz	R. W. Kaye
	J. L. McCammon	R. W. Carter	J. L. Hostler	M. L. Johnson
	J. T. Creighton	C. W. Young	J. L. Neece	T. Rich
	J. G. Bradley	D. K. Franz	R. W. Kaye	D. E. Bartholomew

PAST OFFICERS

1994-1995

President	J. A. Van Huis
Sr. Vice President	M. L. Bradley
Jr. Vice President	J. A. Lileikis
Jr. Vice President	R. W. Carter
Secretary	P. A. Weissmann
Treasurer	D. J. Lewis
	J. L. Hostler
Directors	J. L. Neece
	R. W. Kaye
	M. L. Johnson
	T. Rich
	D. E. Bartholomew
	P. L. Barrett
	D. W. Cook
	R. C. Dummar

CONSTITUTION

(Revised September 18, 1990)

ARTICLE I

NAME

Section 1. This Association shall be known as the American Railway Bridge and Building Association.

ARTICLE II

OBJECT

Section 1. The object of this Association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway structures and fixed facilities by investigation, reports and discussions.

Section 2. The Association shall neither endorse nor recommend any particular devices, trademarks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussion unless the same have received the endorsement of the Association in regular session.

ARTICLE III

MEMBERSHIP

Section 1. The membership of this Association shall be divided into five classes: Members, Life members, Associate members, Honorary members and Junior members.

Section 2. A member shall be a person in the railway industry (except representatives of manufacturers and/or suppliers of equipment, material or labor services) engaged in engineering, construction and maintenance of railway structures and fixed facilities; a person in the employ of a public regulatory body; a professor of engineering or architecture; a technical editor; a materials expert; a consulting engineer, or an engineer employed by a consulting engineering firm, engaged in the engineering, construction and maintenance of railway-related facilities; an engineer employed by a technical service or research and development organization; or an officer or engineer of an engineering or scientific society or association whose aims and objectives are compatible with the aims and objectives of this Association. Any person desirous of becoming a member shall make application upon the form prescribed by the Executive Committee, setting forth the applicant's name, address and practical experience. The applicant shall be recommended by at least one member of the Association to whom they are personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the Executive Committee, a majority vote being necessary in either instance.

Section 3. To be eligible for a life membership, an individual must have belonged to the Association for at least 15 years and in general must have retired from active employment due to age or physical disability. A life member shall have all the privileges of previous membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2 of this Article.

Section 4. Associate members shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to cooperate with members in the study and development of improved practices in the construction and maintenance of railway structures and fixed facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2 of this Article, except that they shall be recommended by either a member or an associate member of the Association to whom they are personally known.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the majority vote of the members present at a regular meeting. They shall have all the rights of members except that of holding office and shall be exempt from the payment of dues.

Section 6. Any person in the Association membership whose conduct in any way diminishes the professionalism or prestige of the Association, or who shall refuse to comply with the rules of this Association, shall forfeit membership in the Association on a two-thirds vote of the Executive Committee.

Section 7. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 8. Only members shall hold office in this Association, and only members and qualified life members shall be entitled to vote in the election of officers.

Section 9. Junior members shall be persons engaged in academic study toward a career in those areas described in Section 2 of this Article, but not currently employed in those areas. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members in Section 2 of this Article, except that they need not be recommended by a member of the Association. The term of junior membership shall be limited to five years.

ARTICLE IV

OFFICERS

Section 1. The officers of the Association shall be a president, a senior vice president, two junior vice presidents, a treasurer and nine directors, who, with the most recent past president, shall constitute the Executive Committee.

Section 2. The past presidents of this Association, previous to the most recent past president, who continue to be members shall be privileged to attend all meetings of the Executive Committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the Executive Committee without delay.

ARTICLE V

EXECUTIVE COMMITTEE

Section 1. The Executive Committee shall manage the affairs of the Association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the Association, and make all necessary purchases and contracts required to conduct the general business of the Association, but shall not have the power to render the Association liable for any debt beyond the amount then in the treasury plus accounts receivable and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the Association.

Section 2. Meetings of the Executive Committee may be called by a majority of the members of the committee, providing ten days' notice is given to the executive committee by mail.

Section 3. Five members of the Executive Committee, one of which shall be either the president or a vice president, shall constitute a quorum for the transaction of business.

ARTICLE VI

ELECTION OF OFFICERS AND SECRETARY AND TENURE OF OFFICE

Section 1. Except as otherwise provided, the officers shall be elected at the regular annual meeting of the Association and the election shall not be postponed except by a two-thirds vote of the members present at said annual meeting. The election shall be by vote, a majority of the votes cast being required for election. Any member of the Association not in arrears for dues shall be eligible for office, but the president shall not be eligible for re-election.

Section 2. The president, two junior vice presidents, and treasurer shall hold office for one year and the directors for three years; three directors being elected each year. The senior vice president shall hold office for one year and ascend to the office of president at the expiration of such service. All officers shall retain their office until their successors are elected and installed. A director elected for a three-year term shall not be eligible to serve two consecutive terms.

Section 3. The term of office of the treasurer may be terminated at any time by two-thirds vote of Executive Committee. The compensation of the treasurer shall be fixed by a majority vote of the Executive Committee.

Section 4. The secretary shall be appointed by a majority vote of the Executive Committee and the term shall terminate with the appointment of successor. The Executive Committee shall have the power, by two-thirds vote, to remove the secretary and appoint a successor at any time. The salary of the secretary shall be decided by a majority vote of the Executive Committee.

Section 5. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the Executive Committee.

ARTICLE VII

MEMBERSHIP FEE AND DUES

Section 1. Every member, upon joining this Association, shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the Executive Committee.

Section 2. A person stricken from the list of members because of non-payment of dues upon written application may be reinstated as a member in the former class of membership without loss of privileges, either upon payment of all back dues (which must accompany applications) or at the discretion of the Executive Committee voting in the manner prescribed in Section 2 of Article III.

ARTICLE VIII

LOCAL SECTIONS

Section 1. Upon the application of ten or more members of the Association residing in the same geographical district, or having offices therein, the Executive Committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this Association as the section membership may adopt and the Executive Committee approve.

Section 2. The parent Association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

By-Laws

(Revised July 11, 1994)

Time of Meeting

1. The regular meeting of this Association shall convene annually during the month of September, the exact date to be fixed by the Executive Committee.
2. It shall be within the power of the Executive Committee to change the time of the meeting if it becomes apparent that it is for the best interests of the Association.

Place of Meeting

3. The place of holding the annual meeting shall be determined by the Executive Committee not less than twelve months prior to the date of the annual meeting.

Quorum

4. At the regular meeting of the Association, 15 or more members shall constitute a quorum.

Dues

5. The annual dues for the fiscal year ending August 31, and payable in advance, shall be as follows:
Members, \$25.00; Associate Members, \$25.00; Junior Members, \$25.00

Duties of Officers

6. The president shall have general supervision over the affairs of the Association. He shall preside at all meetings of the Association and of the Executive Committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. The president (or appointed Executive Committee member) shall render a detailed report at least three times during the year to the members of the Executive Committee, showing the financial condition of the Association and its activities.

At the annual meeting the president (or appointed Executive Committee member) shall present a report containing a statement of the general condition of the Association.

7. The vice presidents, in order of seniority, shall preside at meetings in the absence of the president and discharge the duties of the president in case of a vacancy in his office. The senior vice president shall have the senior position of vice presidents.

8. The secretary shall keep a correct record of the proceedings of all meetings of this Association, and of all accounts, between this Association and its members, collect all moneys due the Association, and deposit the same in the name of the Association. The secretary shall pay all bills when properly certified and approved by the president or the treasurer, and make such reports as may be called for by the Executive Committee. The secretary shall sign all contracts or other written obligations of the Association which have been approved by the Executive Committee. The secretary shall also perform such other duties as the Association may require.

9. The treasurer shall have charge of the funds, check all deposits as made by the secretary, and invest all funds not needed for current expenses. The treasurer shall report at each annual meeting on the condition of the finances.

Nominating Committee

10. After each annual meeting the president shall appoint a committee consisting of five members. The most immediate past president shall act as chairperson. No other officers of the Association shall be appointed to this committee. This committee shall prepare a list of names of nominees for officers to be voted on at the next annual meeting in accordance with Article VI of the Constitution, said list to be read at the business session of said meeting. Nothing in this section shall be construed to prevent any member making further nominations provided that such nominations are received by the president in writing not less than thirty (30) days in advance of the first day of the annual meeting. Such nominations should be addressed to the president of the Association at its headquarters office.

Auditing Committee

11. Prior to each annual meeting the president shall appoint a committee of three members, not officers of the Association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

Orders of Business

12. The order of business at the annual meeting of the Association shall be as follows:

- Call to order by president
- Opening prayer or invocation
- President's address
- Presentation of papers, reports and special presentations
- Reports of standing committees
- Business Session
 - Report of Secretary
 - Report of Treasurer
 - Report of Auditing Committee
 - Report of Nominating Committee
 - Election of Officers
 - Necrology Report
 - Unfinished business
 - New business
- Installation of officers
- Adjournment

The order of business may be modified by the Executive Committee prior to the meeting, and is subject to change by the chair, unless protested by a majority vote of members present.

Decisions

13. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the Association, unless otherwise provided. Unless specifically provided herein otherwise, all discussions shall be governed by Robert's Rules of Order.

Amendments

14. The By-Laws can be amended by a two-thirds vote of those present at any regularly called Executive Committee Meeting.



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(UL CLASSIFIED FOR MAN RIDING)



Model 8A - Model 16A - Model 32A

ADVANTAGES

- Materials and man-riding applications (U.L. Classified)
- High output, light weight
- Stamped steel casing with double galvanized protection
- Activating levers aligned with the wire rope
- Overload protection by shear screw, easy to replace
- Quality controls: 100% testing at 125% of nominal capacity
- Optional "Cazador" safety devices

TECHNICAL SPECIFICATIONS

Model	Nominal Capacity *	Max. Pulling Capacity	Cable Travel Speed (per cycle)	Action effort on handle	Net weight (no cable)	Weight with Packing (no handle)	Packing Dimensions	Original ALBA Wire Rope	
								Diameter	Breaking load
8A*	1,700 lbs.	2,750 lbs.	2 1/4 in.	64 lbs.	14 lbs.	17 lbs.	17 5/16"x 3 9/16"x 11	5/15 in.(8.3mm)	10,550 lbs.
16A*	3,400 lbs.	5,500 lbs.	2 9/32 in.	88 lbs.	30 lbs.	35 lbs.	22 3/4"x 4 3/4"x14 1/4"	7/16 in.(11.3mm)	21,120 lbs.
32A*	6,800 lbs.	11,000 lbs.	1 3/4 in.	116 lbs.	52.5 lbs.	58 lbs.	27 9/16" x 5 1/2" x 15"	5/8 in.(16.3mm)	42,240 lbs.

* U.L. Classified for man-riding applications



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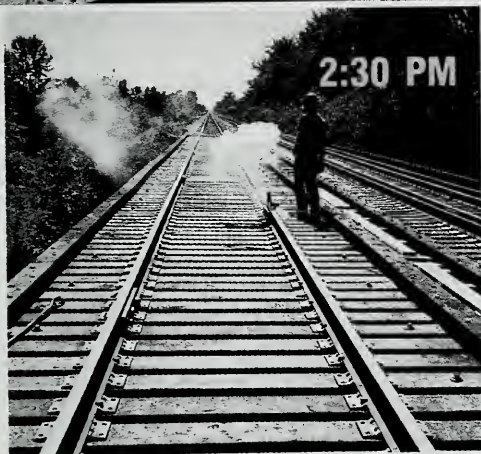
7:30 AM



9:30 AM



12:30 PM



2:30 PM

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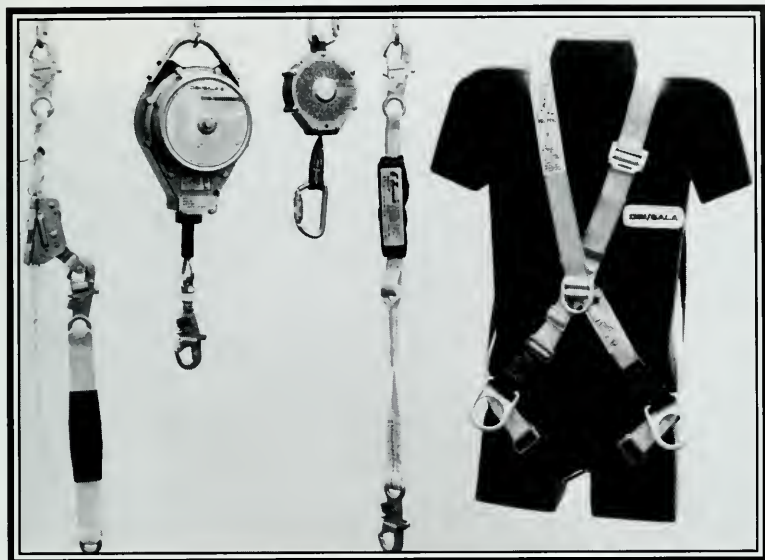
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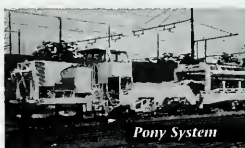
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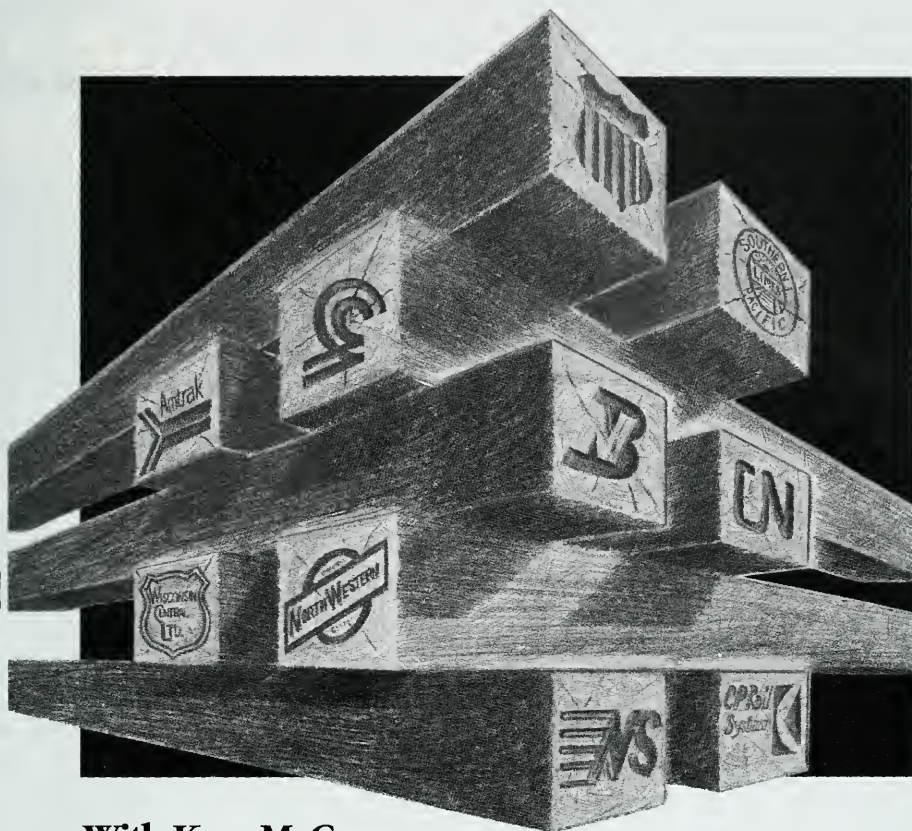
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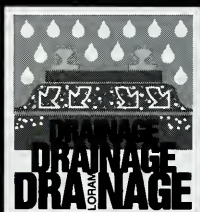


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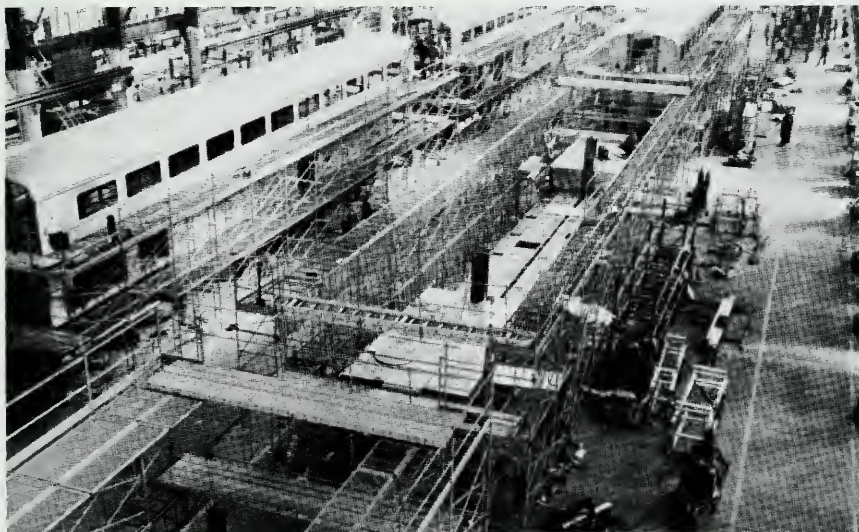
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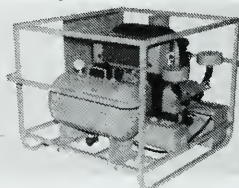
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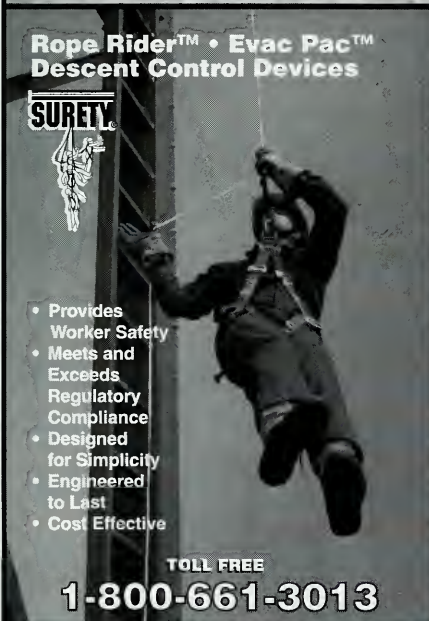


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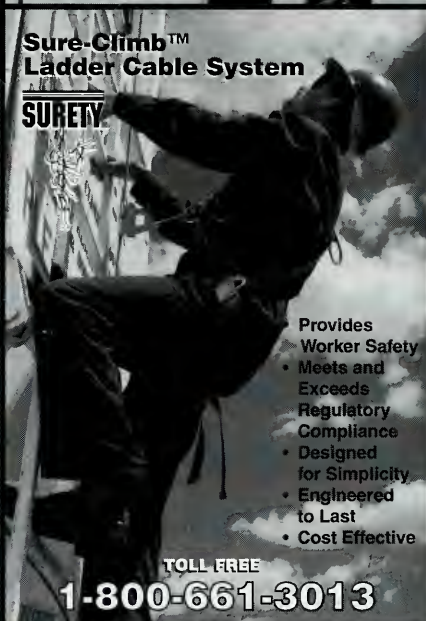


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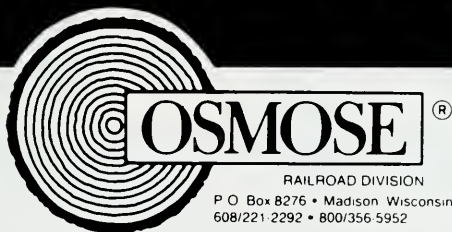
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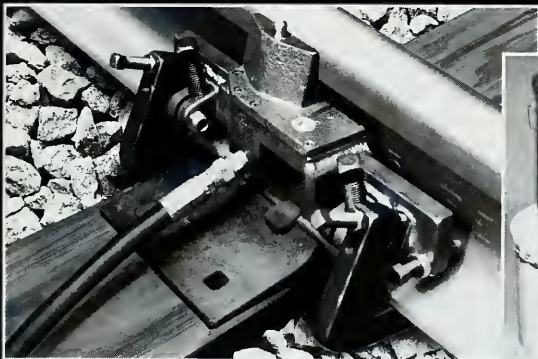


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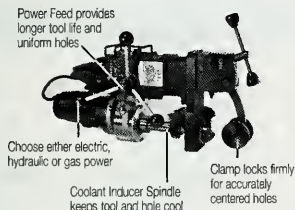
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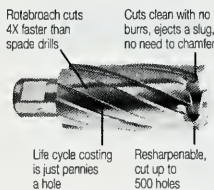
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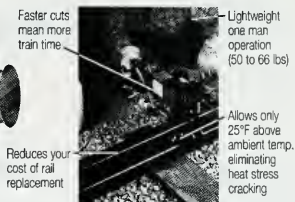
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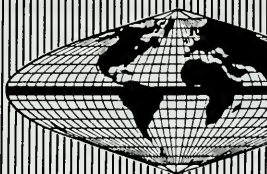
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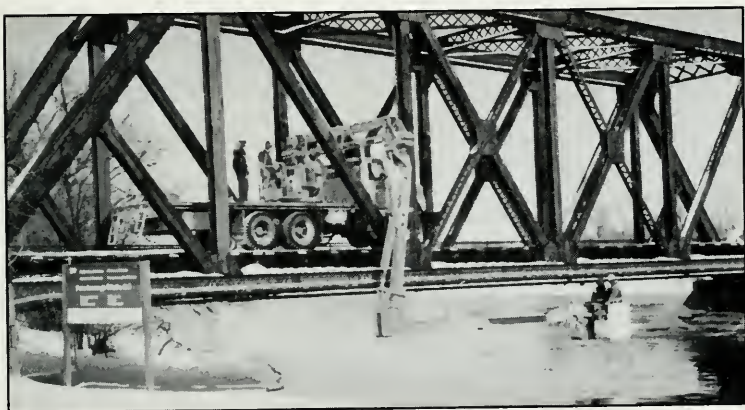
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